Railway Engineering Maintenance

July, 1935

The

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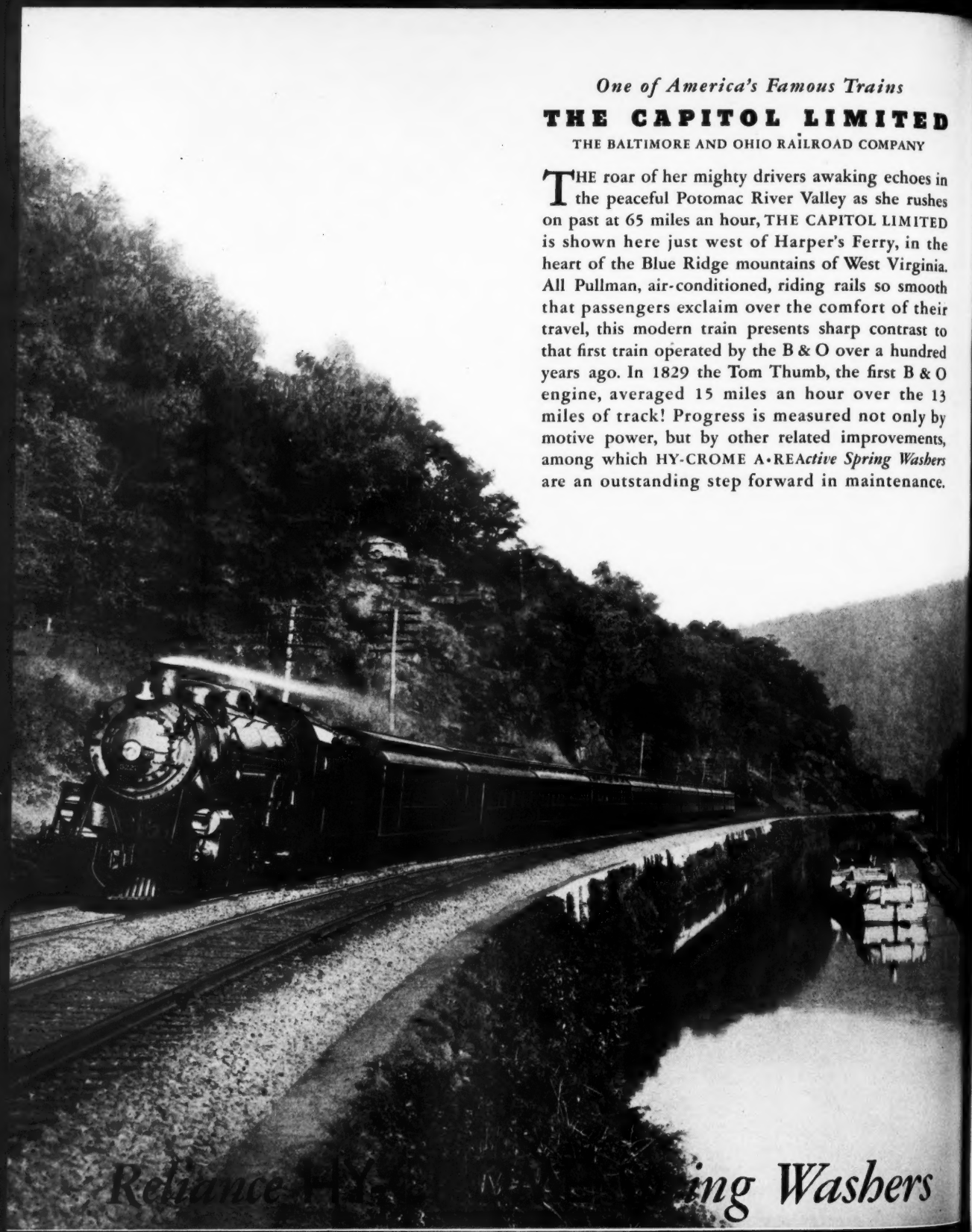

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THE BALTIMORE AND OHIO RAILROAD COMPANY

THE roar of her mighty drivers awaking echoes in the peaceful Potomac River Valley as she rushes on past at 65 miles an hour, THE CAPITOL LIMITED is shown here just west of Harper's Ferry, in the heart of the Blue Ridge mountains of West Virginia. All Pullman, air-conditioned, riding rails so smooth that passengers exclaim over the comfort of their travel, this modern train presents sharp contrast to that first train operated by the B & O over a hundred years ago. In 1829 the Tom Thumb, the first B & O engine, averaged 15 miles an hour over the 13 miles of track! Progress is measured not only by motive power, but by other related improvements, among which HY-CROME A•REA*ctive Spring Washers* are an outstanding step forward in maintenance.

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Meets A. R. E. A. Spec.	*For screw spike use*	*For track bolts*	*For general use*	*For frogs—crossings*	*For special use*	*Used as a*

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Unit of Union Carbide and Carbon Corporation

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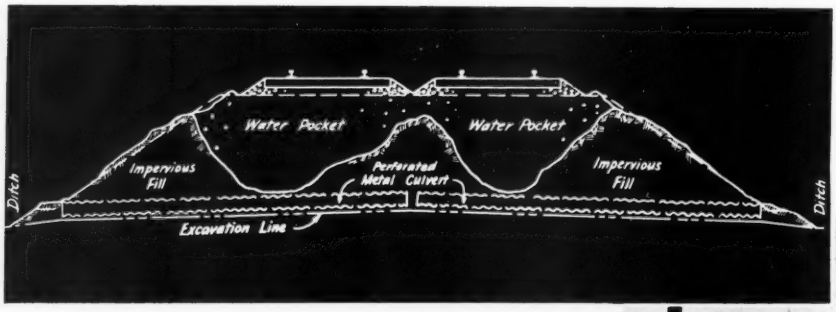
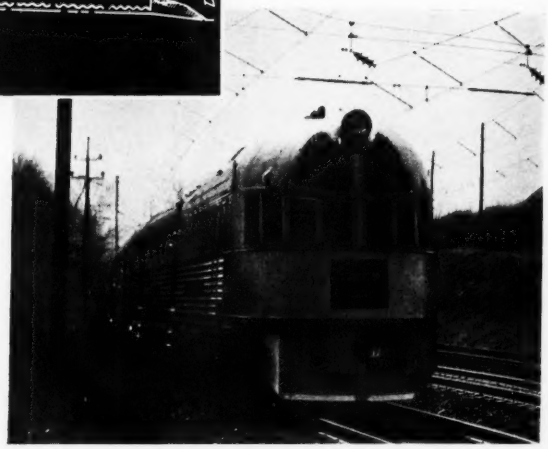
OXWELD RAILROAD SERVICE

Published monthly by Simmons-Boardman Publishing Company, 105 W. Adams St., Chicago, Ill. Subscription price, United States and Possessions, $2.00; Canada, $2.50; Foreign $3.00. Single copies 35 cents. Entered as second-class matter January 20, 1933, at the postoffice at Chicago, Illinois, under the act of March 3, 1879, with additional entry at Mt. Morris, Ill., postoffice. Address communications to 105 W. Adams St., Chicago, Ill.

HIGH SPEEDS DEMAND BETTER DRAINED ROADBEDS





• With the new era of high speed, railway engineers are confronted with new responsibilities. It is an established fact that safe and efficient operation of fast trains demands stable and properly drained roadbeds. Soggy or improperly drained pockets and inadequate cross-drainage invite danger. Eliminate these hazardous locations by installing modern drainage systems. TONCAN IRON PERFORATED PIPE is specified by engineers, because they know that its use will insure more efficient performance and low maintenance cost. The Toncan Culvert Manufacturers' Association employs a corps of skilled drainage engineers, who will be glad to cooperate with you in solving your drainage problems.

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The BARCO UNIT TYTAMPER represents a small initial investment with extremely low cost of maintenance.

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The BARCO UNIT TYTAMPER is simple in design and rugged in construction and may be taken apart and re-assembled very quickly by the ordinary workman and does not require highpriced experts.

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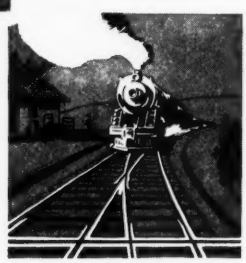
LOOKING AHEAD

Steel for



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United States

with the RAILROADS

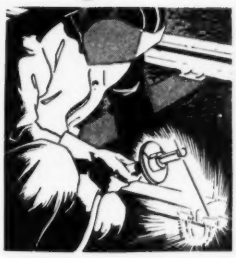
NOT since the days of the opening of the West and the first transcontinental trains have railroads been so much in the public eye. A generation that had come to accept the railroads as a matter of course is now eagerly watching for news of fresh achievements, of faster schedules, of greater comfort, of gripping innovations.

The public "sees" railroads in terms of trains. Yet 1935 railroading is far more than a matter of streamlined locomotives and stainless steel cars.

Take trackwork, for instance: Higher and higher standards of maintenance are essential as schedules are sliced by hours. Better track fastenings, longer-lived rails, smoother switches and crossings. Here—as in most phases of railroading—steel has worked shoulder to shoulder with practical railroad men in the improvement of products, the anticipation of needs, the modernizing of service.

Shown here are a few of the outstanding trackwork products manufactured by subsidiaries of United States Steel Corporation. They are helping you make 1935 service faster, safer, more economical, more efficient. And from these same companies are scores of technicians available for consultation, for information, and for service. Whatever your need in steel, the United States Steel Corporation Subsidiaries can supply it.

every Track Requirement



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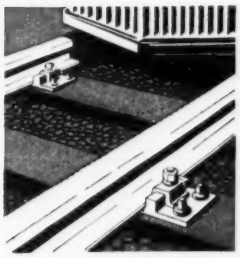

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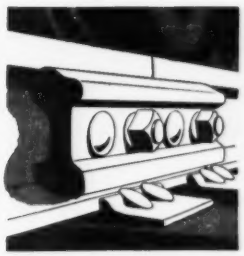
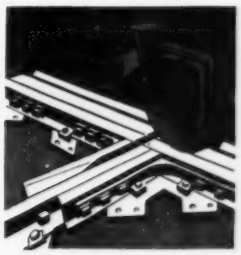
GEO assures smooth, quiet track—greater safety—lower maintenance. GEO aids in preventing derailments from rail tilting and gauge widening.



RAILS, SPLICE BARS and TIE PLATES

Every known section or design is produced by one or more of the companies here listed. Product quality means safety and economy of use.



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No. 79 of a series

Railway
Engineering and Maintenance

SIMMONS-BOARDMAN PUBLISHING COMPANY

105 WEST ADAMS ST.
CHICAGO, ILL.

Subject: Readership

June 27, 1935

Dear Reader:

Every once in a while we receive a letter that arouses unusual interest. Such a letter was received recently from C. E. R. Sherrington, secretary of the Railway Research Service, London, England. I quote from this letter:

> "In your letter to your readers which you published in the August, 1934, issue of Railway Engineering and Maintenance, you inquired regarding your oldest reader.
>
> "While we in this office cannot claim any such recognition, since our organization dates back only to the summer of 1924, you may be interested in knowing that we have complete files of your publication from the issue of October, 1924, and have, on behalf of the four British railways, sub-indexed every issue in great detail for the last 10 years.
>
> "In addition we have had requests to borrow our file copies at frequent intervals, not only from the chief officers of our British railways, but also from railway administrations abroad, and copies have on occasion been lent to railway administrations in France and Germany. Naturally our file copies here are also available to visiting officers from Australia, Argentina, India and South Africa, not to mention continental European countries."

All too frequently we think of the influence of a magazine such as ours as confined to the railways of America. Letters like that from Mr. Sherrington bear tribute to the high regard with which railway officers in other countries hold American railway practices and American railway materials.

This letter also affords evidence of the wide readership of Railway Engineering and Maintenance. We have long contended that our average subscriber shares his copy with at least one other person. Are we correct? What evidence can you give me?

Yours sincerely,

Elmer T. Howson

ETH:EW

Editor

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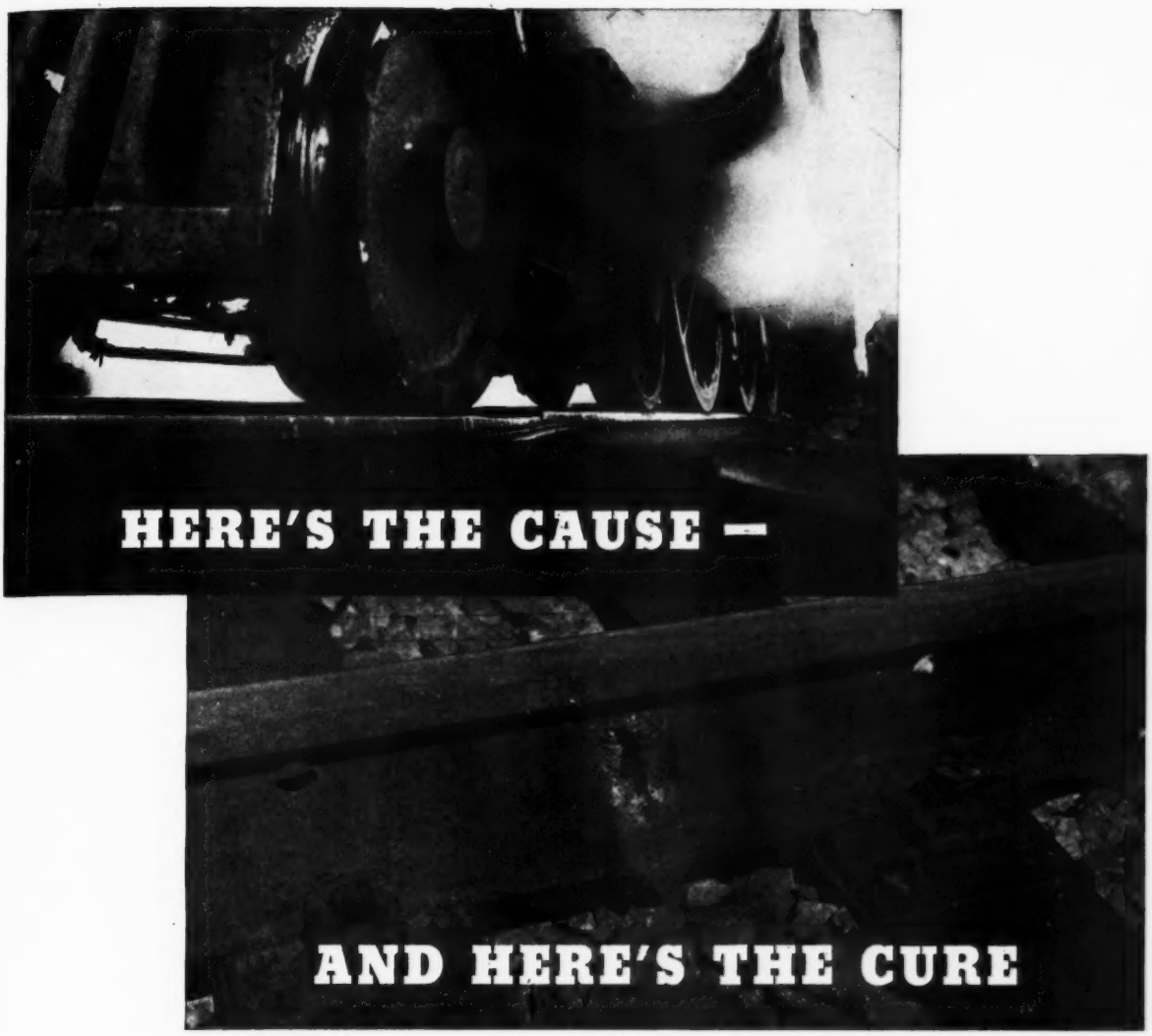

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Thermit Pressure Rail Welds can be installed by your own track forces at a cost comparable with ordinary rail joints... and, the first cost is the last. Write for the complete story.

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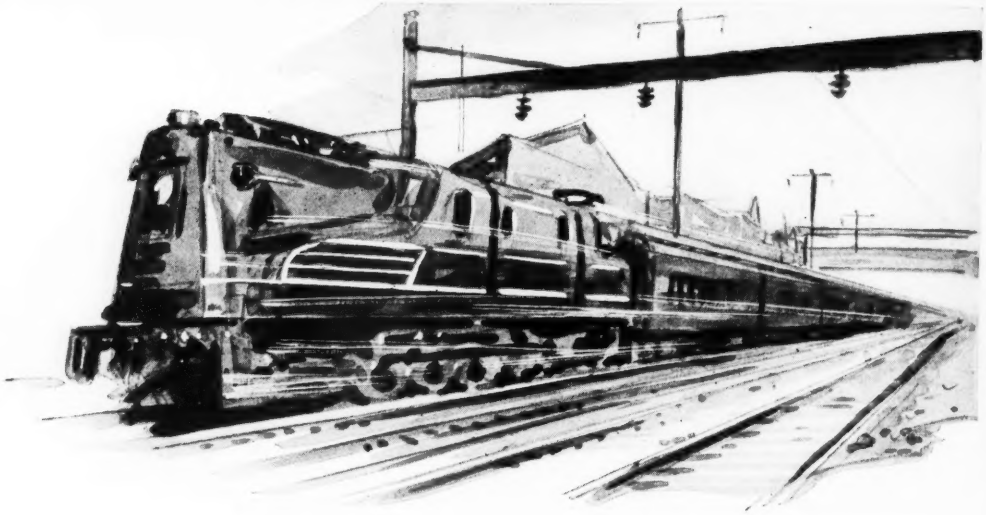

Today—more than ever rail ends must be kept up!

High-speed trains are the order of the day. Streamlined locomotives and cars are appearing in ever increasing numbers. But streamlining is only one essential in attaining the speeds that are being sought. Perfect condition of trackage is equally necessary. Rail ends *must* be kept up.

The AIRCO-DB TWO-FLAME TIP

Speeds up AIRCOWELDING and heat treating of rail ends by providing double the amount of heat of the single tip. Interchangeable with the regular tip of the AIRCO-DB AIRCOWELDING Torch. Write for details.

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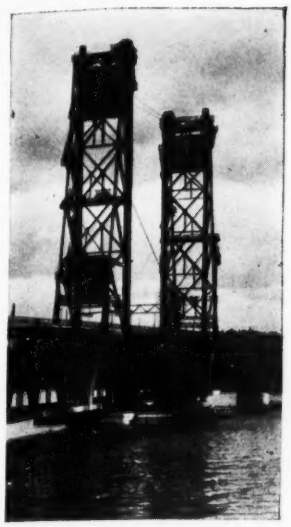

Railway Engineering and Maintenance

NAME REGISTERED U. S. PATENT OFFICE

July, 1935

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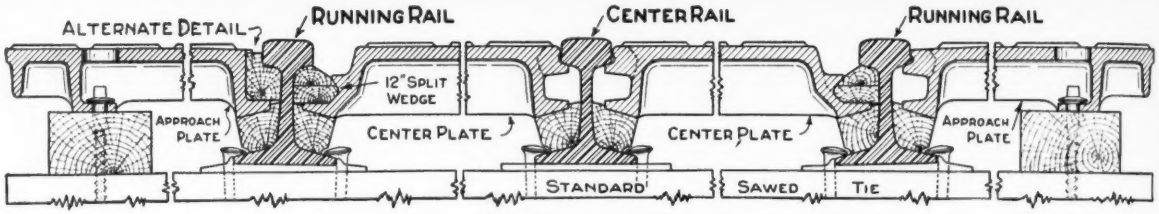

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GOOD WILL—These crossings eliminate widespread criticism by the public when riding over rough crossings. Smooth, quiet-riding crossings also eliminate some of the agitation for expensive grade crossing elimination projects.

SAFETY—The plates are toe-checked on top, to prevent skidding, and they are heavily ribbed on the underside for strength, with effective insulation between the railroad running rails.

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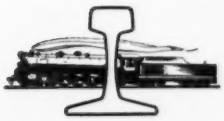
Railway Engineering and Maintenance



Dust Storms and Floods

But Traffic Must Continue to Move

IN OUR May issue we described the unprecedented catastrophe that had befallen many of the railways in the plains areas by reason of the prevalence of dust storms day after day until hundreds of miles of tracks had been covered, and operation was maintained only with the greatest difficulty. In the areas subjected to these storms, ballast was fouled, ditches filled and equipment and machinery put out of commission. All in all, losses were incurred running into the millions of dollars.

In this issue we are describing a disaster of another but equally destructive type—the washing out of many miles of lines. Here within 48 hours a single railway suffered damage exceeding two million dollars within a distance of 250 miles. Other railways in this area were also severely hit, although not so seriously as the railroad referred to specifically in this article. Furthermore, what happened to the railways in this immediate area has happened, in a smaller way, to roads in other areas where hundreds of washouts have occurred within recent weeks.

We have thus experienced, within a period of 60 days, vast destruction of railway property and a vast overload on maintenance forces, brought about by an extreme and long sustained drought and then equally great destruction and an equally severe load on the maintenance forces resulting from excessive rainfall. Whether through drought or fainfall, these extremes have placed burdens on maintenance forces, the magnitude of which is adequately appreciated by few railway officers, let alone the public at large.

Taken for Granted

The age through which we are passing has become so highly specialized that every person is of necessity becoming more and more closely confined, with the result that we know less and less of the achievements of those in other walks of life. Out of this comes a lessening of appreciation of the accomplishments of others and, in turn, we become more and more accustomed to take for granted services that are of vital necessity to our well being, with little thought of the organizations that make such services possible.

Rail transportation is such a service. The citizen at large expects his mail to come to him with clock-like regularity; he expects his markets to be stocked with the season's fruits and vegetables from remote areas; he expects trains to be on time. All this he takes for granted, with no thought of the obstacles which maintenance men must overcome, frequently under the most severe handicaps, to insure the continuity of such service.

Consider the records of recent weeks for a moment. In the vast plains area of the central and south west, one dust storm followed another in such succession and in such severity that track men not infrequently had to follow the right of way fence, hand over hand, to avoid losing their way back to headquarters. Yet they patrolled the tracks with such diligence and labored so relentlessly in keeping switches open and other facilities operating that traffic continued to move and not a single patron of a railway lost his life or incurred a serious injury. Likewise, in the flood of May 30-31 when a single railway suffered destruction at dozens of points and trains were marooned between washouts ahead of and behind them and when more than 100 persons resident along the lines of this railway lost their lives, not a single passenger nor a single employee of the railroad was drowned or injured.

Military Precision

Aside from this remarkable record for the protection of life, the work of restoration has been equally outstanding. With the precision of an army, the work of reconstruction was divided into sections, each in charge of an experienced maintenance officer with ample authority to meet the conditions in his area and supported by a service of supply which assembled and dispatched materials in carloads and trainloads.

Indicative of the magnitude of these latter activities was the dispatching from one material concentration yard of a solid train of 35 cars of material in a single movement, which train had been loaded and sent on its way even before the full extent of the damage was known. Another road drove more than 1¼ miles of timber trestle within two weeks, the material for which came from points hundreds of miles distant.

Such work, undertaken without a moment's warning and yet conducted with a degree of efficiency and a regard for costs that belies the rapidity with which the work is done, is accepted by maintenance forces as part of the day's work. Yet it reflects a responsibility that is found in no other agency of transportation. The railways exert maximum efforts to repair damage of this character in order that commerce may be resumed.

Not so with other agencies. When highway traffic comes to a standstill, those who are engaged in this form of transportation assume no responsibility for the reconstruction of the roads; they throw none of their forces into the emergency; they spend none of their income for

rehabilitation but await expenditure by public authorities. The same is true of the air lines which suspend operation without hesitation in unfavorable weather.

Deserving of Emphasis

This action of the railways in the face of disaster is one that merits greater emphasis than it now receives. It is a phase of railroading in which every railway man should take pride and especially every maintenance man. The records which the railways have made in overcoming the effects of dust storms and floods alike reflect great credit on the men who comprise this service—even more, they reflect a public service of the highest order. It is a service of which the public should be adequately informed in order that, when so informed, it will become equally appreciative, and give to the railways the patronage that such service deserves.

No group of railway employees is entitled to take greater pride in such achievements and no group of employees is better fitted to carry this story to the public than the maintenance employees. The disasters of recent weeks constitute an opportunity and a challenge to every man in the maintenance department to disseminate the story of the achievements of the railroads of the country in the face of disaster.

Construction

Practices that Reduce Maintenance Costs

OFFICERS of track maintenance may find some consolation for the many trials of the depression years in the fact that the decline in construction has greatly reduced the mileage of new roadway that they are required to maintain. But no doubt most of them can point to a considerable amount of trackage completed before the crash of 1929 that afford ample justification for comments on the shortcomings of the construction department.

While there are some grounds for complaint on the score that low unit prices for grading have been the primary consideration in handling construction and that not enough attention has been given to measures that would make for rapid solidification of embankments, trouble with settlement or subsidence under traffic has not been confined to fills constructed since the advent of the modern dump car and the spreader. Investigations during the course of federal valuation disclosed ample evidence of severe settlement in embankments that date back to the days of the scraper, the wheeler and the wheel barrow.

On the other hand, trouble with settling embankments in recent years is resulting in a change in construction practices. Some railroads are insisting on the use of porous, readily compacted material in back filling behind the abutments of grade separation structures. One road that has had a great deal of experience in filling high trestles, has recently abandoned the practice of dumping from cars in favor of the use of motor trucks and requires that the fill be placed in layers not more than four feet thick. As a matter of fact, the effectiveness of modern rubber-tired and crawler-mounted equipment for the hauling of filling material has resulted in the substitution of trucks for both standard and narrow-gage cars in a large part of the railroad grading done in recent years, although full advantage of the opportunity for the building of the embankments in layers has not been taken in all cases.

While some railroads have endeavored to avoid trouble where especially unfavorable conditions have been encountered, by wasting unstable material excavated from cuts, by providing extremely flat slopes on fills placed on soft ground, or by other special measures, this policy has not been as general as it should be. There is still room for improvement in the planning and execution of railways construction to the end that extraordinary maintenance expenditures will be avoided.

Heating Plants

Their Efficiency Can Be Increased

ON MANY roads, the inspection of heating plants is just getting under way; on others it has been completed; and on still others it will not be started for several weeks. This indicates a difference of opinion as to the best time to make this inspection. One of the arguments advanced for the later date is that heating plants sometimes suffer damage during the period of summer idleness and that it is better to make the inspection late enough to insure that they will be in first-class shape when the heating season opens.

In part at least, the practice of starting the inspection of heating equipment early in July is one that has been inherited from the days when railway fiscal years ended on June 30, when it was not uncommon for a railway to defer until after July 1 all but the most necessary expenditures, and sometimes some of those that were necessary. As a result, the custom developed of planning to do after July 1 much of the work that is now started early in the spring. Among the practices that have not been changed on all roads with the change in the fiscal year is that of inspecting and ordering repairs to heating equipment.

Those who advocate early inspection contend that the best time to examine heating equipment with the view to putting it in first-class shape is late in the spring just before the plants are closed down. They point out that defects are more easily detected while the plant is in operation, and that even some serious defects cannot be seen at other times. Among those that are more easily found during the operation of the plant are leaking joints, leaking valves, defective vents and vacuum valves, pipes partly or wholly filled, incipient cracks in the fire box or boiler front and others which may cause considerable losses or lead eventually to the failure of the plant. Again, if the plant is in service, it is more likely that faulty operating practices will be discovered than if it is idle.

Probably the most serious criticism that can be made of the methods of inspection and maintenance of heating plants is that these are too often left entirely to the local building or water service forces. Few of these men have technical, or even extensive practical, knowledge of heat-

ing requirements or experience in heating practices, and while they do the best they can, they seldom have the broader knowledge that is necessary to keep the plants up to their highest efficiency. For this reason and because they are busy with many other tasks, if the plant provides sufficient heat, they seldom bother about details of economy.

This leads to the conclusion, which has been confirmed by experience, that a road which has a considerable number of heating plants can well afford to employ a heating engineer. On a system of any size he will more than repay his salary in the amount of fuel saved every year, as compared with the former practice of uncoordinated maintenance and operation, especially if his duties include attention to the larger heating systems in shops, enginehouses and similar buildings.

Anti-Creepers

How Much Attention Do They Need?

IS THE maximum potential benefit being obtained from anti-creepers? In other words, how much attention do they receive after they have been applied? The anti-creeper is an effective device which performs a single service and, in general, performs it well. It is simple; it is easily applied; it requires practically no maintenance. If properly designed and applied, it should continue to function as long as it is allowed to remain on the rail. Yet no device, no matter how simple or effective, can be expected to produce the best results if it is consistently neglected.

More than one case has been observed where insufficient anti-creepers have been applied to overcome fully the tendency of the rail to creep. In such cases, the creepage may be small; yet certain of the ties will be partly off of their beds and the expansion cannot be kept uniform. An additional anchor or two to the panel would have prevented these conditions at far less cost than that of the labor involved in making the correction while, unless the needed anchors are added, it may be necessary to repeat the corrective measures from time to time.

An anti-creeper which does not come in contact with and bear firmly against the tie is entirely useless, and the investment it represents might just as well have been saved by leaving it off. Better yet, however, it should be reapplied in such a way as to cause it to function. An anti-creeper that is loose, because of either poor design or error of application, is equally useless and has the additional disadvantage that it is likely to rattle as trains pass over it. If it is of poor design, it should be replaced with one of good design. If it has been applied improperly, this should be corrected at once or, if it has been damaged as a result of mistreatment, replaced with a new anchor.

Probably no single track accessory has done more than the anti-creeper to assure stability to the track, through the elimination of rail creepage. At the same time it has been a definite factor in prolonging the life of both rail and ties. It has been developed to the point where, in most cases, if it has been applied properly, it functions automatically and consistently. Yet this dependability should not be used as a basis for neglecting to inspect its performance from time to time to insure that it is functioning properly. Cases in which anti-creepers have failed have occurred too often to warrant taking a chance. It is true that most of these failures can be traced to improper practices on the part of the maintenance forces, but the cause of the failures, except for purposes of discipline, is of less importance than that reliance is being placed in a device which is actually performing no service or performing it inadequately.

Track Tamping

Choose the Method Best Adapted for the Work

THERE are two distinct methods of tamping ties. In one, commonly known as lock tamping, alternate cribs are opened outside of the rail and the ties are tamped from one side only, the tamping inside of the rail being done from the opposite side of the tie. In the other method, the tie is tamped from both sides. The question is often raised as to which is the better method, and sharp differences of opinion exist. Both methods have been used with success in ballasted track and the advocates of each find convincing reasons in support of the method they favor.

One of the fundamentals of good track is that the ties shall have an even bearing both inside and outside of the rail; otherwise neither line nor surface can be maintained satisfactorily. One of the advantages claimed for lock tamping is that less labor is required, since only alternate cribs are opened, for which reason a gang can surface more track in a given time, while the undisturbed crib provides a backing which permits the tamped ballast to be packed tightly.

On the other hand, when making a light raise, so much time and effort are required to force the ballast to the opposite side of the tie that it is doubtful whether time is really saved. It is not easy to force ballast 8 or 9 in. back from the tamping face and one is never sure that he has done so or that he has compacted it uniformly across the width of the tie. If he has not, the tie will not have a uniform bearing and both line and surface will suffer.

In light surfacing, opposite tamping is more reliable than lock tamping, for it is far easier to force the ballast half way across the tie than across the full width. Furthermore, every man in the gang knows definitely whether he is getting his ties tamped, and as they are all open to inspection, the foreman should also know. In addition, so much less effort is required that the opening of all of the cribs is warranted.

If track is raised as much as an inch, lock tamping, properly supervised, is fully as reliable as opposite tamping and actually saves the time that is claimed for it. If the raise is still more, it is quite likely to be superior to opposite tamping. It will be seen, therefore, that both methods have their place and that if the method best adapted for the work in hand is chosen, it can be applied successfully.

Rebuilding a Railroad in Twenty-Three Days

The months of May and June, 1935, will be long remembered for the extensive flood damage to the railways in the territory between the Mississippi river and the Rocky mountains. However, the experience of the Burlington in the Republican River valley in Southern Nebraska, where 216 miles of line were rendered unserviceable for 23 days, stands out as a major disaster. This article presents the story of this flood and outlines the measures adopted by the railroad in marshalling its resources to meet the emergency that it created.

ON the morning of May 31, Trainmaster E. H. Piper and Master Carpenter E. W. Bradley, were proceeding westward by motor car on the main line of the Chicago, Burlington & Quincy in the Republican River valley to the scene of a washout. Shortly after 10 o'clock, when they were in the vicinity of Rupert, Neb., they found that the track ahead of them was covered with water, and had scarcely turned the car around and started it in the reverse direction when, prompted by an ominous roar, they looked around and saw that the valley was being engulfed by a veritable wall of water. By the time they had scrambled to a point of safety up the hillside, the entire floor of the valley was submerged by a raging torrent that carried on its crest such a burden of houses, fences, bridges, brush, trees, and smaller debris as to leave no question as to the destructive power of the flood.

A Great Disaster

During all that day and throughout the following night as the flood wave moved down the valley, hundreds of other people had similar experiences, and in some cases with less fortunate results, for 104 persons lost their lives in what proved to be a major flood disaster. The recession of the waters revealed an appalling scene of desolation. The crops and stock on hundreds of farms had been destroyed, buildings on the farms and in the towns had been washed away, displaced or overturned, and two small villages, Max and Parks, had been virtually wiped out, while the Burlington's line throughout the 216 miles between Haigler, Neb., and Superior suffered such severe damage as to require 23 days of the Herculean effort before it could be restored for through service.

Within this distance, an aggregate of 41.5 miles of track was swept off the roadbed—in some cases to distances of as much as 200 yards from the right-of-way. Much of it was turned bottom-side up with the characteristic "cork-screw," and in a few cases it was twisted through a complete 360-deg. turn. Numerous holes were cut in the embankments and in other places as much as two feet of silt and sand was deposited on the track.

Only the bridges escaped serious damage, for while the track was lifted bodily off many of them, only two suffered structurally and in both cases the damage was due to parts of the superstructures being swept away, rather than to undermining of the substructures. However, in a great many cases the bridges were isolated by washouts at one or both ends.

The line involved in this disaster is a part of the Burlington's main stem from Denver, Colo., to the east, which follows the valley of the Republican river from Haigler to Superior on a water grade averaging about 10 ft., to the mile, and the stretches of 0.5 per cent maximum grade against westbound trains are relatively short. The floor of the valley, from two to three miles wide, is relatively flat, so that the railroad, which lies near the foot of the hillside on the north is supported for the most part on light fills, the few cuts being generally shallow. Located in a territory where rains of severe intensity, although usually of short duration, result in rapid runoffs down the rather steep slopes of the lateral streams, the railroad has had its share of washouts during the half century since this line was built. High water in the valley has occasionally given trouble, but at no time has there been any flood even remotely approaching the one that occurred on May 31.

Cause of the Flood

The flood in the Republican River valley came as a climax of an epidemic of high water troubles during the last two weeks of May and the early part of June from which few railroads in Kansas, Nebraska, Colorado and neighboring states escaped. A week of heavy rainfall in Eastern Colorado and Southwestern Nebraska had caused the Republican river to overflow its banks, and produced such heavy discharges from several of its tributaries as to cause a number of washouts where they crossed the Burlington's line. These had been repaired and traffic restored when a great cloudburst occurred at the head waters of the south fork of the Republican river and a tributary stream, the Arikaree river, in Eastern Colorado, followed by extreme rainfall in the drainage areas of the north fork of the Republican, Big Blackwood creek, Red Willow creek, Medicine creek and other streams that enter the valley below Haigler, the timing of these downpours being such as to produce an extraordinary concentration of runoff in the main valley.

In addition to the damage suffered by the main line, a mile of embankment on the St. Francis (Kansas) branch was washed out near Orleans, Neb., and a pile trestle across an overflow channel lost several bents and all of its deck, although the main river bridge was not injured. Near Republican, also, the flood pushed the three 107′ truss spans of the river crossing of the Oberlin (Kansas) branch off the piers. Furthermore,

The photographs reproduced on the opposite page were taken by a member of the editorial staff of Railway Engineering and Maintenance along the Burlington's line in the Republican River valley east of McCook, Neb.

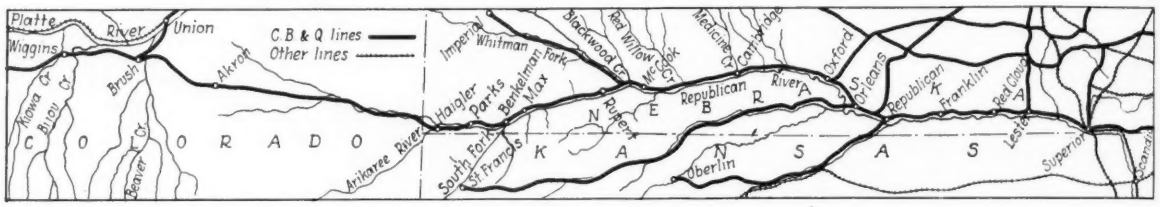
the same storm that caused the heavy discharge in the south fork of the Republican river and the Arikaree river, covered the head waters of Kiowa, Bijou and Beaver creeks, resulting in torrential flows in these streams that caused severe washouts where they cross the Burlington east and west of Wiggins, Colo., and east of Brush. In addition, high water in the South Platt river swept the track off about ¾ of a mile of roadbed south of Union, and there were also several washouts near Hillrose on the line between Brush and Sterling.

Much Walking Required

This was the situation that confronted the system officers of the Burlington when they arrived on the scene on the morning of Saturday, June 1, although it was several days before the exact nature and extent of the damage could be determined. The reason for this is obvious. Between Oxford, Neb., and Brush, a distance of 220 miles, the main line of the Burlington has no connection with any other line that affords a means of access, and because of this and the further fact that the highways throughout the valleys were also seriously damaged, it was necessary for members of the railway organization to walk much of the distance between Oxford and Haigler, and from the former point to Superior, in order to make a survey of the damage. No damage was done for about 90 miles between Brush and Haigler, but owing to the washouts described above, this section of the line was completely isolated. Although locomotives and cars were available in the engine terminal at Akron, Colo., so that shuttle service could be conducted over that part of the line, no pile drivers, other work equipment or materials could be moved in from the west to assist in the restoration operations east from Haigler.

As a consequence, the work of restoration was concentrated first on the washouts near Wiggins and on the line between Brush and Union under the immediate direction of J. H. Aydelott, general manager of the Lines West of the Missouri river. In the meantime, E. Flynn, executive vice-president, assumed general charge of the work in the Republican River valley, making his headquarters at Oxford and assigning detailed supervision of the operations west of Oxford to H. R. Clarke, engineer maintenance of way, and on the portion of the line between Oxford and Superior, to F. R. Mullen, general superintendent, Lincoln, Neb., who established headquarters at Orleans, Neb. A large part of the work carried on was cleared through L. E. Caldwell, division superintendent of the lines involved.

Immediate supervision over the work on sections of the line from 20 to 30 miles long was assigned to district engineers maintenance of way and other officers, with the assistance of roadmasters, track supervisors and master carpenters, each of whom was placed in charge of certain operations or sub-districts. Ralph Budd, president of the Burlington, spent the better part of two weeks in the affected territory, advising with the officers in charge concerning the major problems presented.



The Burlington's Lines in Eastern Colorado, Southwestern Nebraska and Northwestern Kansas

Owing to the fact that it was primarily the track rather than the roadway or bridges that suffered the most severe damage, it was seen at once that the immediate requirement was man-power to put stretches of track in condition for the movement of rail equipment, such as pile drivers, as rapidly as possible. Two extra gangs engaged in surfacing between Oxford and Haigler comprised the immediate force at hand and these were quickly supplemented by three extra gangs that were moved in from maintenance operations elsewhere on the road. In addition, word was passed to the section foremen to increase their gangs, and in the absence of sufficient tools, imposed the condition that a man must supply his own shovel or a pitch fork in order to get a job. Further extra gangs were organized as quickly as tools and camp outfits could be provided for them, several extra-gang foremen being sent into the affected territory to organize gangs of local men that could be employed without the problem of housing and feeding.

Except for the two gangs on the ground before the flood and gangs recruited locally, extra gangs had to be housed in camp cars set out on tracks at the several points of rail access, the men being hauled out each morning in motor trucks and supplied with noonday lunches by the same means. However, these camp outfits were moved ahead as rapidly as the track was restored.

Two locomotive cranes with clamshell buckets, in the engine terminal at McCook, together with a pile driver marooned at Cambridge, were the only pieces of work equipment in the territory between Oxford and Haigler, and while the former were used, with the aid of a worktrain, in embankment replacement east of McCook, lack of bridge material precluded the use of the isolated pile driver until repair work on the highways and the acquisition of a truck and trailer capable of hauling 60-ft. piles made it possible to deliver material to this machine. Where material could be delivered to a pile driver by rail, the work was greatly expedited by setting an "American Eagle" crane directly behind the driver to unload material cars and pass the piles and timbers forward, thereby avoiding the delays incurred in having the driver back up to pick up material. In the meantime, every effort was made to procure off-track equipment locally, especially crawler-mounted drag-line machines, as these proved especially effective in restoring embankments and in dragging track back on the roadbed. Owing to the fact that difficulty of access required them to move long distances on their "tracks," some delays were encountered in getting them to the points of work. One of these machines was hauled 300 miles by truck for use on the St. Francis branch. Some embankment restoration was also done with teams and slips.

Obstacles Imposed

Except for work that could be done by track gangs in restoring track, progress east from Haigler was delayed until June 10, when, owing to the closing of the gaps in the line in the vicinity of Brush, it was possible to move in a pile driver and other work equipment as well as material from the west. Owing to this delay in

starting pile driving work from the west, and to the fact that the pile driving in the 100 miles between Cambridge and Haigler had to be done by no more than two machines working from opposite ends, every effort was made to reduce the amount of driving necessary by constructing fills with drag-line machines, or by using them to build "shoo flies," over which the driver could be moved ahead in order that a following driver might be cut in to fill the gap. However, owing to the large amount of track work that had to be done before a pile driver could be moved from one break in the roadbed to the next one, the progress in pile driving was slow during the first week, but as the work of restoring the track throughout the entire territory was advanced much greater progress was made. The work on the line between Oxford Junction and Superior could be handled to much greater advantage, both because the distance is less and because operations could be conducted from four fronts, namely, east from Oxford and west from Superior, and both east and west from Lester, where a connection is made with a branch line from the north.

Some Manual Work

Where the roadbed was not seriously damaged and the track was not displaced, the initial work of restoration was largely a manual operation, shovel tamping the ties with material from the roadbed and doing whatever lining was necessary to permit safe movement at slow speed. In some cases small holes in the roadbed were filled by hand, although crawler-mounted drag-lines were used wherever possible and these machines were employed also in pulling the track back onto the roadbed. However, a large part of this operation was also conducted manually—barring the rails off of the ties and then lining them into place in long stretches without breaking the joints. Where the track was not off the embankment but was distorted or out of line, it was lined by hand, and in the absence of a sufficient number of lining bars for the enlarged section forces, 2-in. by 4-in. scantlings, chamfered along the edges near one end to form a handle, or even fence posts, were employed. No little difficulty in lining track resulted from the fact that silt, filling up the spaces between the rail ends in the joints, made it impossible to drive out the excessive expansion introduced when the track was bowed out of line by the flood. In some cases it was necessary to cut out a piece of rail before the track could be lined.

A contingent result of the flood was the drastic changes that took place in the topography of the valley floor. The torrential discharge cut new channels for the Republican river and its tributaries—in many cases at appreciable distances from their former beds, and deposited great masses of silt and sand over large areas. As a consequence the ground surface is now level with the base of rail in some locations where the track had been supported on embankments up to six feet in height, and stream crossings have been cut through the roadbed several hundred feet from the bridges originally provided for them.

So extensive are these physiographic changes along the Burlington's line, that A. W. Newton, chief engineer, and F. T. Darrow, assistant chief engineer of Lines West, proceeded at once to make a detailed study of the altered topography in its relation to the roadway and structures, that could serve as a basis for decisions with respect to local changes in grades and the requirements as to the location and size of waterway openings, side ditches, etc. The waterway requirements, in particular, have been thoroughly investigated by G. A. Haggander, bridge engineer of the system. Every effort was made to apply this information in the construction of bridges across the washouts, but inasmuch as the studies cannot be completed in their entirety for some time, it was decided that all pile trestles driven to restore service should conform to the standard trestle plans and that creosoted piles and timbers should be used in all cases where it was reasonably certain that the structure occupied a permanent waterway channel.

Service of Supply

Upon receipt of the first reports of extensive flood damage, orders were placed with the stores department for all manner of bridge and track materials, and evidence of the expedition with which these were filled is afforded by the fact that 65 cars of piling, timbers and ties were loaded at the company's timber treating plant at Galesburg, Ill., in two days, and that 35 of these cars were despatched in one train. The first heavy call for bridge material was occasioned by the extensive washout at Wiggins, Colo., where it was necessary to drive a bridge to replace a 363-ft. plate girder structure that had been destroyed.

On the work of restoration along the Republican river, the primary job at the start was to restore sections of the track to a passable condition so that the pile drivers and material trains could be moved in. And until considerable progress had been made in this initial stage of the work, the primary need was for tools, camp outfits, work equipment and work equipment supplies, and a limited supply of track fastenings.

Because of this condition and the limited capacity of the tracks at the points of rail access, particularly at Oxford, special precautions were taken to avoid congestion and confusion in the ordering and delivery of materials and supplies. Under the direction of R. D. Long, general storekeeper, who established temporary headquarters at Oxford, a field office of the stores department was set up at that place in charge of E. J. Clark, and instructions were issued that all requisitions should be cleared through him and that they should indicate where and when the materials were needed. This arrangement not only insured the prompt loading of materials at the system storehouses at Aurora, Ill. and Havelock (Lincoln) Neb., and at the timber treating plants at Galesburg, and at Sheridan, Wyo., so that material could be forwarded on passenger trains if necessary, but in as much as it was just as important to avoid delivery in advance of actual need, this plan insured that materials would be held on cars under load at Havelock or on sidings at intermediate points between Havelock and the points of rail access to the flood district until just prior to the time of specified delivery. Plans were also set on foot to provide a supply of suitable ballast and other track materials not needed for the work of restoring train operation, in order that a program of complete rehabilitation could proceed immediately after the line was opened for traffic.

The stores officer at Oxford assumed responsibility for delivery to the point of use and as much of the material had to be moved over the highways, he was placed in charge of a fleet of trucks that was organized for this purpose.

After the extent of the destruction had been carefully surveyed and the work of restoration had been thoroughly organized, a study of the progress being made led to the conclusion that the line could be opened for through traffic on June 25. As the work proceeded, every indication pointed to its earlier completion, but a heavy rainfall on June 16 resulted in another flood of considerable severity but smaller scope that washed out 600 ft. of "shoo-fly" embankment at one point and 300 ft. of restored embankment at another. However, in spite of this, service between Denver and the east was restored on June 23,

Solving the Problem o

In its search for economical and effective methods of controlling plant growth the Northern Pacific has employed various types of equipment and materials. In this article, which is abstracted from a report prepared by H. M. Stout, assistant valuation engineer of the Northern Pacific, the various methods are described and cost records and results given.

THE Northern Pacific embraces more than 7,600 miles of main tracks, including about 830 miles of second, third, and fourth main line tracks, and nearly 3,800 miles of branch-line main tracks. It traverses the northwest section of the country, extending from the cut-over timber and lake areas of Minnesota across the prairies of North Dakota and Eastern Montana, over three lofty mountain ranges in Western Montana and Idaho, through the volcanic ash beds and irrigated valleys of Central Washington, over the Cascade mountains in Western Washington and thence through the forests and cultivated lands of the western slope.

Conditions Vary Widely

In such a broad region the railroad naturally encounters a wide range of topographical, climatological, meteorological and soil conditions, which tend to produce a variety of plant growth. Elevations vary from 612 ft. above sea level at the head of the Great Lakes and a maximum of 6,328 ft. at Homestake, Mont., in the Butte mountains to sea level at Pacific Coast points. The driest region along the company's lines is in Southeastern Washington where the mean annual precipitation is 6.24 in. at Connell, while the wettest spot is on the other side of the Cascade mountains at Kalama, Wash., where the mean annual precipitation is 71.65 in.

The warmest section is in the vicinity of Kennewick, Wash., where the mean annual temperature is 53.8 deg. F. The coldest point is at Sand Point, Idaho, where the mean temperature is 28.6 deg. F., the next lowest mean temperature being 38.8 deg. F, at Superior, Wis. The average growing season varies from 88 days at Deer Lodge, Mont., to 250 days at Seattle, Wash.

Corresponding to the diversity in the conditions influencing plant growth, there is a wide range in the species of flora encountered along the company's lines. These include chick weed, clover (red), dandelion, fern (Bracken), grasses (mixed), morning glory, mustard, orchard grass, plantain, quack grass, railway grass, Russian thistle, salt grass, sweet clover, wild lettuce, wild roses, wild oats, willows and wire grass. The weed which is most troublesome, particularly in the territory where the ballast consists of washed gravel, is "horsetail."

In general, the region of most prolific growth of weeds and vegetation lies west of the Cascade mountains where the weeds become troublesome early in the spring while in some years the growth may be continuous throughout the winter. By far the greatest trouble is presented by the various species of annual plants, most of which grow from seeds scattered by birds and winds. In addition, some species of perennial plants occur in localities favorable to their growth, adding to the unkempt appearance of the roadway or even encroaching upon the track if unrestrained. The species of this class of most frequent occurrence is the willow.

In general, there are four reasons for removing weeds from railroad tracks and rights-of-way: (1) To remove obstructions to train operation; (2) to improve the appearance of the property; (3) to eliminate the fire hazard presented by fallen dead vegetation; and (4) to comply with the legislative requirements of states and municipalities.

The amount of expense and effort devoted to weeding operations depends on the degree of cleanliness of the property that is desired. As with other items of maintenance, the greatest attention is devoted to the main tracks where practically complete elimination of plant growth is desired. On branch lines it is usually considered sufficient to keep the weeds below the top of the rails.

The following methods of weed destruction have been employed on the Northern Pacific:

1. Hand-weeding with shovels, hoes and scythes.
2. Discing the ballast shoulders and hand weeding between the ends of the ties, the discs being mounted on motor cars.
3. Mowing with equipment mounted on motor cars.
4. Burning with oil, the burner being handled by work train.
5. Killing with steam applied by equipment handled by work train.
6. Burning with oil, using a self-propelled machine.
7. Spraying with chemicals.
8. Oiling the roadbed.

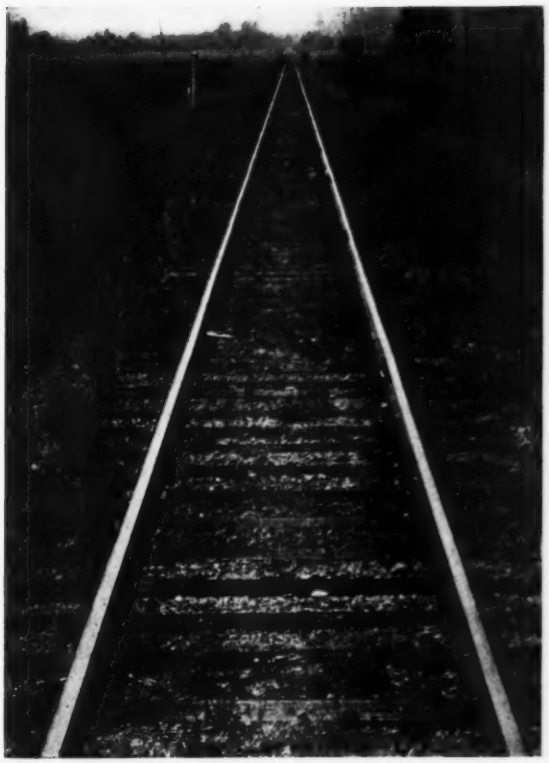
If considered a nuisance, weeds growing on the right-of-way outside of the limits of the roadbed are generally removed by the section forces by hand, with a mowing machine or, less frequently, by burning. The application, limitations and costs of these methods of weed killing are of such common knowledge that they will not be discussed further.

The discing of ballast shoulders is a method of eradicating weeds that has been developed during the last decade. Various machines have been developed to carry out this operation, which embody several different principles. A light type of discer consists of three discs on each side of a section motor car, the discs being mounted on steel arms or wings which can be raised or lowered as required. A heavier type of the same make consists of a gang of eight discs mounted on each side of a track motor car about 15 ft. long. Still another machine has a disc and two blades mounted on each side of a section motor car, while a fourth type has five discs on each side.

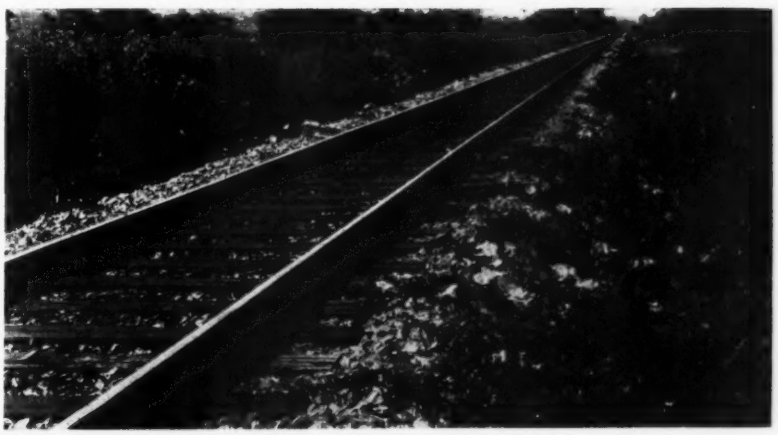
One of the machines with three discs on each side was acquired by the Northern Pacific in 1917, and heavier types of the same make were purchased later, one in 1927 and another in 1930. Meanwhile, a machine of the type with a disc and two blades was obtained in 1924.

These machines are being used

Weed Control



The Problem of Weed Control Varies with the Type of Ballast, Climatic Conditions and the Character of the Line Involved



principally in Western Montana, North Dakota and Western Washington, on branch lines having gravel ballast. One machine is being operated over main line track in Montana, although it is not used on track ballasted with washed gravel as the use of discers in this type of ballast is considered objectionable because they tend to mix the ballast with the dirt at the toe of the ballast slope. Ordinarily the discers are operated by the section forces, three men being required.

No particular effort has been made to maintain cost and other records on the operation of the discers, although certain records are available. In 1927, the roadmaster reported that the operation of a heavy-type discer on the Red River branch was entirely satisfactory. The machine killed the weeds thoroughly in the ballast shoulders and, moreover, the dragging and dressing affect of the discer resulted in an improved appearance of the shoulders. Sections of the line were gone over twice, while three discings were required where the sod was bad. The total mileage covered was 409, at a cost of $1.03 per mile of discer operated, or $2.22 per track mile for the 190 miles of branch line. The cost includes wages, supplies, interest and depreciation. The weeding between the ends of the ties was done by hand.

The light-type discer was first placed in operation in North Dakota on a branch line having dirt ballast. However, this ballast baked so hard in the sun that the discer could not penetrate it sufficiently to accomplish results of value. The machine was then moved to Montana and employed successfully on main line track ballasted with pit-run gravel.

Track Mowing Machines

The first track mowing machines were placed in operation on the Northern Pacific in 1922, seven machines being purchased in that year and six the next, all of which were of the same type. This machine is mounted on a standard insulated push car, and power is transmitted to the mower attachment through gears from the axle of the push car, the latter being propelled by a section motor car. The mower attachment consists of a standard sickle, the sickle bar being arranged to operate at any angle desired. This machine cuts on one side of the track only and can be thrown in and out of gear by the foot of the operator.

In the beginning, considerable trouble was encountered in the operation of these track mowers because the 6-hp. engines with which the propelling motor cars were equipped were connected directly to the axles and developed their full power only at a speed considerably in excess of the four to six miles per hour required for the efficient operation of the mowers. An improved type of the same make of track mower, which had an extension bracket and longer Pitman rod for the sickle, permitting the swath to be started farther away from the track, was developed later, of which the railroad placed 9 in operation in 1925, 10 in 1926 and 5 in 1927. In addition, the objection to the direct-connected motor car was overcome by using motor cars with two-speed transmissions, which adapted them to slow-speed use.

The Northern Pacific placed its first power-operated track mowers in operation in 1928, two different makes being installed. Both of

these machines are mounted on steel-frame, four-wheel track cars propelled by section motor cars, and cut on both sides of the track simultaneously.

In one type two extra sickle bars are provided, with the necessary attachments for cutting a second swath outside of the first. The sickles on this machine are operated by a 2½-hp. gasoline engine mounted on the frame. One of these machines was placed in operation in 1928 and two additional machines in 1930.

In the other power mower, on which the sickles are operated by a 5-hp. engine, an adjustable head is used for raising and lowering the heel of the sickle bar, and the cutting starts 24 in. from the rail. Three machines of this type were placed in operation in 1928, and five improved models of the same make were installed in service in 1931.

Cost data on the operation of track mowers during the years 1928 to 1931, inclusive, are given in Table I in the next column.

Table I—Operation of Track Mowing Machines

Year	Miles Mowed	Total Cost	Average per Mile
1928	4,079	$ 7,464	$1.83
1929	4,723	9,260	1.96
1930	4,421	7,406	1.68
1931	4,494	5,954	1.32
Total	17,717	$30,084	$1.69

Killing Weeds by Burning

The use of heat or flame for the destruction of weeds was inaugurated on the Northern Pacific in 1903 when three oil-burning weed destroyers were constructed in the company's shops. In these units the burners were suspended beneath a steel-frame car carried on two trucks on which an air compressor was mounted at one end and oil reservoir tanks at the other. The burners were covered by a hood and were located close to the rails.

These units, which burned over a width of about 8 ft., were handled by work trains. They produced satisfactory results in the center of the track but were not entirely effective in the destruction of weeds outside the track. Cost records for the period from 1906 to 1911 indicate that the average cost, including rental and repairs to locomotives, varied between $8.50 and $29 per mile of single burning. Following the developing of a steaming process, which was felt to be more economical and effective than the use of flame, the operation of these machines was discontinued in 1922, and they were dismantled in 1928.

Steam Weed Destroyers

Three steam weed destroyers of a patented type were constructed in the company's shops in 1922, one being placed in operation on the Dakota division in that year and the other two on the west coast in 1923. In each of these units, which are mounted on 40-ft. flat cars, the steaming hoods are divided into three parts and cover a width of 16 ft. and a length of 20 ft. The central or main portion is 8 ft. wide and covers the area between the ends of the ties, while side wings extend 4 ft. beyond the ties. Distributing pipes, through which steam is applied to the vegetation, are contained in the hoods which are raised and lowered by compressed air.

These machines, which are roofed, are propelled by a locomotive equipped with a super-heater for supplying superheated steam to the hoods. The crew for each unit consists of a foreman and a helper who raise and lower the hoods as required. In one day a machine of this type will require about 20,000 gal. of water and 8 to 12 tons of coal.

The experience of the railroad with these steaming units showed that, while they do not kill the hardy or fibrous vegetation, they did wilt the tops of the plants and keep them down to about the same extent as is accomplished by hand weeding, while the less hardy types of plants may be killed. The number of trips over the tracks that are necessary with this type of weed destroyer, therefore, depends on the character of the vegetation and also on the degree of cleanliness desired. On branch lines, where it is desired merely to keep the weeds below the tops of the rails rather than to eradicate them entirely, one trip a year may be sufficient. On the other hand on some main lines it was necessary to operate the steamers over the tracks about as frequently as the territory would have been covered if hand methods had been used.

On the Pacific Coast territory, particularly between Seattle, Wash., and Portland, Ore., it was necessary to make a considerable number of trips a year, possibly a dozen, in order to keep the weeds under control.

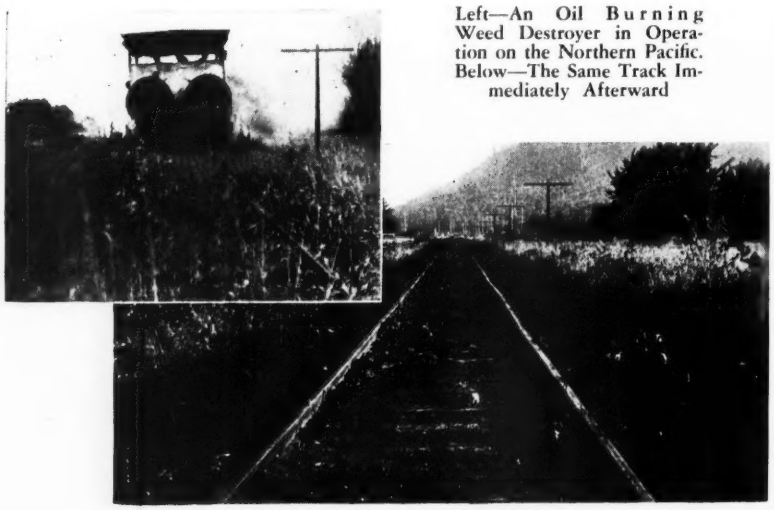
Table II—Operation of Steam Weed Destroyers

Year	Miles Burned	Total Cost	Average Cost per Mile
1922	273.50	$ 4,062.37	$14.85
1923	2,647.87	32,908.80	12.43
1924	3,449.45	41,056.90	11.90
1925	3,397.92	41,023.12	12.07
1926	1,514.78	19,765.81	13.05
1927	688.98	6,551.63	9.51
1928	1,055.50	12,252.95	11.61
1929	843.81	8,871.95	10.51
Totals	13,871.81	$166,493.53	$12.00

The best results from this type of weed destroyer were obtained by making the first application during the early growing season while the vegetation was tender, followed in three or four weeks by a second steaming.

Table II contains cost data on the operation of these steam weed destroyers during the years 1922 to 1929, inclusive.

Self-propelled machines employing flaming oil as the weed-killing agency were introduced about 1925, and one of these machines was purchased by the Northern Pacific in that year. Four machines of the



Left—An Oil Burning Weed Destroyer in Operation on the Northern Pacific. Below—The Same Track Immediately Afterward

The Same Stretch of Track on the Northern Pacific Before and After the Weeds Had Been Destroyed by Chemicals

same make were acquired in 1926, four in 1927, two in 1928 and one in 1929. The oil-burners purchased in 1926 were of the four-burner type but were converted in 1928-9 to the six-burner type. All of the other machines were of the six-burner type; thus the railroad now has 11 six-burner weed destroyers of this make.

Briefly, these burners consist of specially-designed steel frames carried on single-axle trucks, on which are mounted oil tanks and two gasoline engines, one for propelling the unit and another for operating the pump that feeds oil to the burners. Another make of weed burner, having either three or five burners, embodies essentially the same principle. In this machine the fuel tank and the operator's seat are carried on a separate car and the oil pump is operated by the same engine that propels the unit.

Three men, a driver, a pilot or trainman and a man to control the flames and burning operations, are normally required for the operation of weed burners. Usually it is necessary to have a section crew follow the burner for the purpose of extinguishing fires that may become ignited in the track ties or in brush along the roadway. This patrol is particularly necessary in timbered country; in the forest preserves the operation of oil burners is prohibited during the dry season. The speed of operation of these burners varies from 1 to 15 miles an hour depending on the density of the vegetation encountered.

These oil burners will handle a wide range of oils, including gas oil, furnace oil, distillate or kerosene. Any oil which will flow through a ½-in. pipe at the prevailing temperature when the machine is working will ordinarily be satisfactory.

Cost data on the operation of the oil burners are given in Table III. These figures do not include a charge for interest and depreciation which, on the basis of an average service life of 15 years, amounts to $7,290 annually for the 11 machines, or about 86 cents per mile for the 8,502 miles that the machines were operated in 1933.

It is generally agreed that the destruction of weeds through the use of these machines is as effective as the steaming or hand weeding methods. Moreover, an important item in favor of the method of destroying weeds by this method of burning is the greater economy involved as the cost is considerably lower than for either of the other two methods mentioned.

Table III—Operation of Oil Burners

Year	Total Miles Burned	Fuel Oil Used (Gals.)	Total Cost Including Repairs	Aver. Cost per Mile
1928	10,354.5	350,817	$48,787.44	$4.71
1929	10,445.9	380,747	53,171.97	5.09
1930	9,443.3	342,036	48,350.32	5.12
1931	8,335.0	.....	27,414.00	3.29
1932	8,756.3	251,737*	26,529.06	3.03
1933	8,502.0	.....	26,468.22	3.10

*16,850 gal. of this was road oil.

An objection to the practice of destroying weeds by burning is the fire hazard involved, which is most serious in timbered or grain raising country, particularly during dry periods. Another disadvantage that has been mentioned is that the heat draws the oil out of creosoted ties and also burns the ties slightly. However, this objection is generally considered of small consequence at the present time, since conclusive proof as to the amount of damage done, if any, has not been developed.

Chemical Weed Destroyers

The use of chemicals is now an established method of weed destruction. While the cost of application per trip mile is more for the chemical method, only one or two applications are required per season; thus the cost per season mile may be lower. It is also felt that chemicals have a more lasting effect on plant growth than other methods of destroying weeds and the cost is, therefore, still less in the long run.

The first application of a chemical weed destroyer on the Northern Pacific was made on the Lake Superior division in 1927. A poisonous solution was diluted with three parts of water, of which 169 gals. were applied per mile over 71 miles of track. This application was made under contract, the chemical being furnished and applied by the contractor with his own equipment. One treatment was sufficient to achieve satisfactory results.

In 1929, chemical was applied on the Lake Superior, Yellowstone, Montana and Tacoma divisions. A poisonous chemical was diluted with 6.1 parts of water and a non-poisonous compound was diluted with 7.6 parts of water. On July 12 and 13 of that year 84.9 miles of track on the Lake Superior division were sprayed with the poisonous solution and on August 9, 29.8 miles of the same track were sprayed with the non-poisonous solution. Some of the weeds were killed, while the wild grasses turned yellow and revived in a few weeks. On the Yellowstone and Montana divisions 140 miles of track received the poisonous treatment with satisfactory results.

On the Grays Harbor Line of the Tacoma division, 100 miles of track were treated with the non-poisonous solution. The results indicated that one application was not sufficient to keep the weed growth down and it was estimated that three similar applications per year would be required in this territory in order to obtain satisfactory results.

As a whole the results obtained in 1929 fully justified a more extensive program of chemical treatment for 1930. Non-poisonous chemical

(Continued on page 416)

Built-up Roofs Are Generally Applied to Roofs of Large Area, Such as Shops, Enginehouses, Warehouses and Others with Light Pitches

Roofs—

Built-Up Roofing Practice

PROBABLY the most important of all forms of roofing used by the railways is the built-up type, since it is generally used on roof surfaces of large area and on buildings of permanent character. Roofs of this type are applied on wood sheathing and on concrete or gypsum slabs, either with or without insulation, with equal facility and equally satisfactory results.

Roofs of this type also vary widely in design, since they may be laid with from three to six plies and with or without a finishing surface of gravel or slag. Similarly, the materials of which they are constructed vary through as wide a range. Because of the importance of this roofing as well as of the wide range of materials and designs, a large amount of space is given in the manual to roofing of this type. For the same reasons, an introductory section is presented in which the general characteristics of the materials and of the finished roof coverings are discussed and some of the basic rules of application are presented. This section of the manual follows:

Where the slope of a roof is less than four inches to the foot, it is necessary that the roofing be built up in a solid sheet to prevent moisture from being driven through by the wind or from seeping through seams if for any reason it does not drain away rapidly. Roofs of this character are applied on such buildings as shops, engine houses, warehouses, freight stations, power plants and other buildings having large roof areas. Built-up roofs fall into three general classifications based on the materials used in their construction.

Classes of Built-Up Roofing

Probably the oldest, the best known and the most generally used roof of the built-up type is constructed of coal-tar pitch and gravel. This roofing is composed of alternate layers of coal-tar-saturated rag felt and coal-tar pitch, with a top surface of gravel or other suitable mineral. A roof of similar construction is composed of alternate layers of asphalt-saturated rag felt and asphalt. It may or may not be surfaced with mineral. This should be done, however, if the best results are to be obtained and it must be to carry a Class A underwriters' rating. The third class is composed of alternate layers of asphalt-saturated asbestos felt and asphalt. Roofing of this construction may or may not be mineral-surfaced, since it does not require the mineral surface for a Class A underwriters' rating, for which reason the surfacing is generally omitted.

The advocates of each of the various types are able to advance arguments in its favor. Experience has shown, however, that any of them will give service directly proportional to the grade of material and workmanship with which it is constructed.

There are many variations in the combination of materials that may be employed in the construction of roofs of the latter two classes and each manufacturer generally has one that he recommends as being best.

By reason of its comparatively simple construction and the ease with which the materials can be obtained, the pitch and gravel roof is particularly adapted for slopes of two inches or less per foot where long life is required. Such roofing of five-ply construction, when properly put together, may be relied upon to give at least 25 years satisfactory service. Roofing constructed of smooth-top, asbestos felt and asphalt, if the workmanship

and grade of materials are equivalent, may be counted on for equal service. Roofs of this class are rather more difficult to construct, however, so that it is generally preferred not to use it on slopes less than two inches to the foot. It is not to be used on roofs having a slope of less than ⅛ in. to the foot.

Asphalt rag-felt roofing, when properly constructed and finished with a gravel or other mineral surface, may be expected to give excellent service on roofs having slopes of from ⅛ in. to 6 in. per foot, since mineral surfacing can be used with asphalt on slopes as steep as 6 in. However, this type of roofing is more difficult to construct.

All materials, such as pitch, asphalt, sheathing paper, saturated felt, etc., should be housed properly or covered to protect them from the elements or other sources of damage. Built-up roofing should not be applied when rain or snow is falling or during weather cold enough to prevent the work being done properly.

Before applying roofing or insulation over which the roofing is to be laid, the surface to which it is to be applied should be swept clean. If it is to be applied over a wood deck, all loose boards should be nailed securely in place and all knot holes and other openings or cracks ¼ in. or more in width should be covered smoothly with sheet metal nailed securely in place along one side only. If it is to be applied over concrete or other similar surfaces, all holes or sharp depressions should be filled with cement mortar and brought to a level with the surface; all sharp projections that might pierce the roofing should be smoothed down.

Those who are unfamiliar with coal-tar pitch and asphalt sometimes have trouble in distinguishing one from the other. Coal-tar pitch is a product of the destructive distillation of coal in the manufacture of coke or gas. Asphalt may be a product of petroleum having an asphaltic base, such as many of those found in the California fields; a refined natural asphalt, such as that from the deposits on the island of Trinidad or in Mexico; or a mixture of both.

When a block of asphalt is newly cut, it has a bright, lustrous, black surface and a pungent and somewhat rancid odor and taste. When heat of equal intensity is applied to asphalt and coal-tar pitch, the asphalt requires longer heating than the pitch before it is brought to the same liquid condition. When asphalt burns without flame, its fumes are decidedly blue.

When a block of coal tar pitch is newly cut, the surface is a dull black and the material is more brittle than the asphalt. It has an aromatic taste and odor that are characteristic of pitch only. When this pitch burns without flame, its fumes are a dense greenish yellow.

Coal-tar pitch should be heated gradually up to the proper temperature for application which should not exceed 400 deg. F. Although the working temperature of asphalt is higher than that of pitch, it should not exceed 400 deg. F., and it should also be heated gradually. When the proper temperature for either material is reached, the fire should be banked. The heating of a 50-gal. kettle full of coal-tar pitch to the required temperature by means of a wood fire should take not less than three to four hours; for asphalt, although it may be heated more rapidly, this time should not be less than two to three hours. A more rapid heating of either material will damage it, this being particularly true of the coal tar pitch.

In previous articles of this series the rules governing the roofing practices on the Northern Pacific, which have been issued by this road in the form of a manual, have covered asbestos and asphalt shingles and prepared roofing. This article, which is the sixth in the series, discusses the principles of built-up roofs.

The danger of overheating, burning or coking, particularly in the case of pitch, cannot be guarded against too strongly. One way to prevent the overheating of the pitch is to stir it occasionally during the melting process and frequently after it has melted until it is all used. Overheating is preceded by the giving off of a considerable volume of fumes of a light, bluish tinge. Burning is indicated by the rising of yellow fumes from the surface of the pitch. Coking is indicated by the formation at first of a thin crust or coating on the bottom and sides of the kettle. If too much heat is continued, this crust increases in thickness.

If coal tar pitch becomes slightly burned, new pitch should be mixed with it before it is used; if badly burned, it should be discarded and not used. It is quite essential to the life of the pitch not to subject it to prolonged heating, even at low temperatures, as this will drive off some of the more easily evaporated oils that give the pitch its life and elasticity. The best practice is to heat only a sufficient quantity for one day's use.

Although asphalt is not as readily affected by heat as pitch, it also requires the observance of the precautions already outlined. Indications that asphalt is beginning to be burnt are given by the rising of blue fumes from the surface. When this happens, the fire should be extinguished immediately and additional asphalt put into the kettle. If the heat has been excessive and has been continued for some time and the blue fumes have begun to come off in considerable volume for more than an hour, the asphalt should not be used.

Asphalt for roofing is commonly made in two grades:

Grade I. For use on roofs having slopes not greater than three inches to the foot over board sheathing and 1½ in. to the foot over concrete.

Grade II. For use on roofs having slopes not exceeding six inches to the foot over board sheathing and three inches to the foot over concrete.

Care should be exercised to insure that the proper grade of asphalt is specified for the condition under which it is to be used. Precautions should always be taken in advance against fire in the heating kettle. If one starts, water must not be used to extinguish it. Fires of this character may best be extinguished by the use of sand and a supply of sand for this purpose should be kept accessible when operating a heating kettle. Both pitch and asphalt hold heat for a considerable time and workmen should be warned of the danger of being burned.

The distance that heated pitch or asphalt is carried in buckets should be made as short as possible, since the temperature falls rapidly when removed from the fire and the material thickens quickly, preventing proper application. Coal-tar pitch and asphalt do not combine properly and should not, therefore, be mixed. When they are mixed, the resulting compound is a product somewhat resembling putty, except when the amount of one of these materials in the mixture does not exceed five per cent. For these reasons, the same kettles should not be used to heat coal-tar pitch and asphalt unless they have been thoroughly cleaned.

It is good practice to clean the kettles and pails frequently and thus prevent the caking of material on the sides and bottom as will otherwise happen. Wood makes about as satisfactory a fuel as any for heating and after the proper temperature has been reached, a smoldering fire of large sticks can be used to keep the material hot without burning it.

Track Bolts—

Can They Be Standardized?

This is the eighth article of a series dealing with the multiplicity of designs for track materials and tools. Following a discussion of the general problems of standardization, in the November issue, succeeding issues, except March, have contained articles covering rail, track wrenches, tie plates, lining, tamping and claw bars, rail joints and adzes. Spike mauls, sledges and chisels will be discussed in August.

THE track bolt is used universally. It has been in use for more than a century. It is simple. And it is used for only one purpose. It is a necessary unit in all track construction and is bought by the millions annually. For these varied reasons, one might expect that the track bolt would be of a single design or, at most, a relatively few designs.

Yet individual roads are using currently as many as 23 different sizes and shapes of bolts, and in some cases as many as 6 designs for bolts of a single diameter. The situation becomes still more involved when one includes the wide variety of designs for nuts for use on these bolts. In general features, all track bolts are of the same design, in that they are round, they are threaded on one end and they are provided with a head and shoulder on the other end. Beyond these features, however, similarity ceases for there is an astonishing number of differences, many of which are in inconsequential details that do not affect the bolt's utility.

Obviously, the diameter and length of a track bolt vary with the section of rail and the design of the joint. The threads are generally rolled, although they may conform to either the U. S. (American National) standard or the Harvey grip.

Bolts of the same diameter differ in total length and in the length of the threaded portion (G). This latter dimension bears no relation to either the diameter or the length of the bolt, for substantially the same range for G is found in bolts of all diameters. In a lot of nine bolts of the same diameter, selected at random, five lengths were found, ranging from 4⅛ in. to 5½ in. From another lot of 12, all of the same diameter, four bolts 4¾ in. long, had different lengths for G, varying from 1⅞ to 2¼ in.

It is in the head and shoulder that the greatest variations in design are found. So many and so minute are these differences, however, that they cannot be given in detail. In 78 designs, comprising four diameters of bolts, no two were found to be exactly the same with respect to the head and shoulder, although most of the individual dimensions were repeated several times.

In general, the shoulders are oval in section, although a few designs call for a square shoulder. Heads may be of either the oval or button head type. In the former, there are six different dimensions for the head and seven for the shoulder. In the latter, there are three dimensions for the head and seven for the shoulder. It is apparent, therefore, that by varying any or all of these dimensions, an almost unlimited number of designs are possible.

Nuts may be classed as square, hexagonal and "ideal," any one of which may be recessed, giving six types of nuts. The "ideal" designation relates to nuts with chamfered corners on the bearing face. In addition to these different forms, the width and depth of the nuts vary between relatively wide limits. The U. S. standard, which is accepted generally by industry other than the railways, calls for a depth of nut equal to the diameter of the bolt. With few exceptions, however, the railways demand a depth greater than the standard, this excess ranging from 1/16 in. to ½ in. and, in a few cases, to as much as 11/16 in.

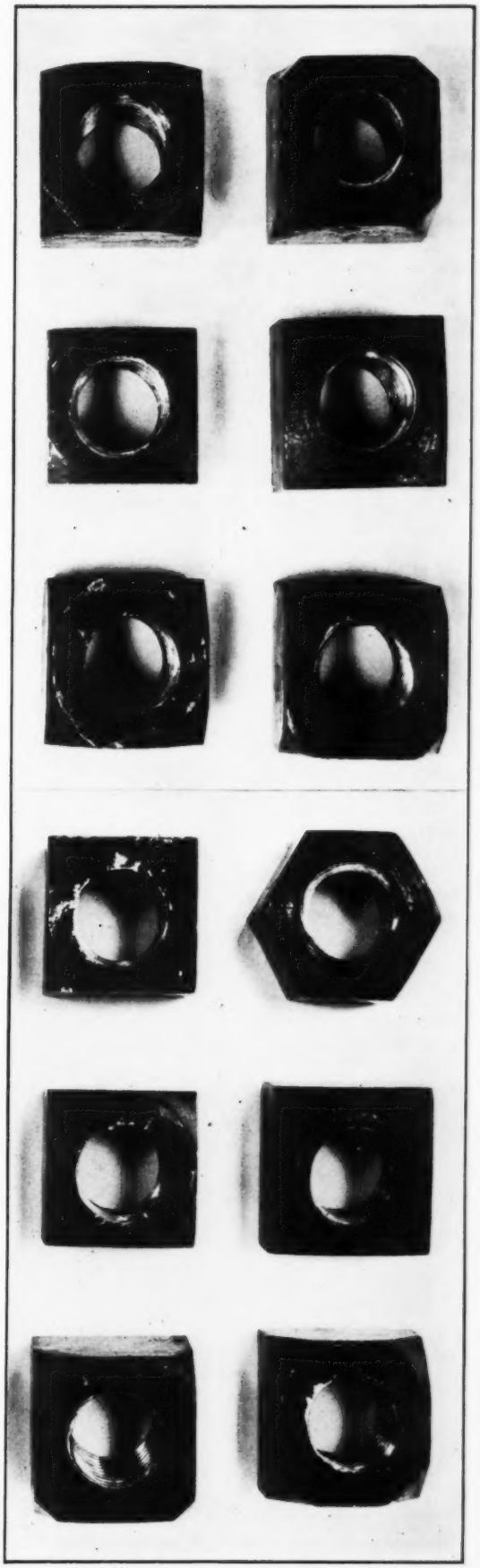
In the "ideal" type, the patterns for chamfering vary within wide limits with respect both to dimensions and to shape. This feature is generally governed by the design of the angle bars, since the corners must be reduced to permit the nut to fit under the rib which forms the head in many designs of joints. This illustrates the manner in which variations in the design of one device may affect the de-

sign of others. Likewise, a change in the design of a joint may necessitate a change in the length of the bolt, while a change in the shoulder or diameter of the bolt makes necessary a new set of punching dies for the joint bars.

Another detail of design of a track bolt in which there is a wide variation in the requirements is in the fit of the nut. The American Standards Association recognizes four designs of fit. No. 1 is a loose fit, No. 2 is a free, but slightly closer fit, while No. 3 is a medium fit and No. 4 is a tight fit. Some roads specify a finger fit; others a No. 2 fit; while still others demand a combination of the two, that is, a finger fit for several turns and a wrench fit for the remainder of the threads.

To illustrate this range, one design demands a fit "so accurate that a 10-in. wrench must be used to run the nut the full length of the thread without distorting the thread or twisting the bolt." Another demands "three finger threads, followed by three threads which shall require the use of a 12-in. wrench and then three threads which shall require the use of an 18-in. wrench." Although this accounts for only about an inch of the threads, nothing is said about the remainder. Still another road calls for a finger fit, followed by a fit that "shall require the use of an ordinary track wrench." Since track wrenches vary in length anywhere from 24 in. to 54 in., this requirement seems somewhat vague.

These Nuts Illustrate the Multiplicity of Designs, for They Differ in Thickness, Width and Shape, So That Each One Requires a Separate Set of Dies, Yet Every Nut Will Fit the Bolt Shown on the Opposite Page



Wrench Load

Recently, a number of roads have specified a wrench load. Again, however, the requirements vary, in this case from a lower limit of 25 to 40 lb. to an upper limit of 80 to 90 lb. applied to either a 15-in. or a 24-in. wrench. Any fit that requires a pull of more than 40 lb. is a close fit, while at the upper limit of 80 to 90 lb., the fit is very tight. Peculiarly, in a few instances the magnitude of the pull is carefully designated, but not the point at which it is to be applied (the length of the lever arm).

It is evident from the foregoing that there is an astonishing multiplicity of designs for track bolts. Furthermore, when the designs are analyzed, little reason can be found for many of the differences, since few of them affect the utility of the bolts or the service that is expected of them. In fact, many of the differences are less than the tolerances permitted by the specifications. There is even greater multiplicity of designs for nuts, for not a few roads are using more than one design of nut on bolts of identical design.

Another element of variation in connection with bolt and nut design is the divergence in material specifications. Some roads have devised elaborate specifications for the bolt, but require only that the nut shall develop the full strength of the bolt. Others include only a minimum yield point for the bolt ranging from 70,000 to 85,000 lb. a sq. in., and a minimum ultimate strength of from 100,000 to 115,000 lb. In one case, a minimum yield point of 35,000 lb. is specified. In the tests, some roads specify only a percentage of elongation; others call for only a percentage reduction in area. A few roads include a Brinnell hardness test for the bolts.

There is also an unusually wide range in the chemical properties specified. Some roads make no chemical requirements, while in a few instances only the phosphorous content of the bolt steel is specified and in others it is the sulphur content of nut steel, which may be as low as 0.05 per cent or as high as 0.18 per cent, or it may be only the carbon content. In other words, the multiplicity of requirements for physical and chemical properties of the bolt steel almost parallels the multiplicity of designs for bolts.

Not the least amazing feature of bolt design is the frequency with which designs for bolts and nuts are changed. As was pointed out in the article dealing with the diversification of design of rail joints in the May issue, one road changed the shoulder and head on its bolts for a single section of rail every year for four consecutive years. While the reasons for doing this are obscure, they are all the more astonishing because no rail of this section was laid during this period, although a large number of angle bars were applied in maintenance. At the end of the four-year period, this road thus had in use five different designs of bolts, and incidentally of angle bars, for a single section of rail.

Many other examples, less extreme perhaps, could be given to illustrate the frequency with which the designs for bolts are changed. The designs for nuts are changed with still greater frequency, it being not uncommon for each of several consecutive orders for bolts to include different designs for the nut. In fact, among the larger roads in the country only one is consistent in its designs with respect to the width and depth of the nut.

Effect

What is the effect of this multiplicity of designs for track bolts and nuts? Is there any reason why a road should not have as many designs, or change its designs as frequently as it desires? Obviously, different weights of rail require bolts of different diameters and lengths, for a 5/8-in. or a 3/4-in. bolt which might be entirely satisfactory for 60-lb. rail would be wholly inadequate for 131-lb. rail. Conversely, it would be absurd to use with a 60-lb. rail section a bolt 1¼ or even 1⅛ in. in diameter, which many engineers consider necessary for 131-lb. rail.

In general, the diameter of bolts ranges from 5/8 in. to 1¼ in., in increments of 1/16 in., and in a few instances of 1/32 in. So long as the older and lighter rail sections remain in service, the demand for the smaller-diameter bolts will continue but as this rail is retired, these bolts will be eliminated, thus automatically eliminating a large number of designs.

As long, therefore, as there are different weights of rail, different sections for individual weights and different designs of joints for individual sections, there will be differences in the bolts that are used with them. The stores department must maintain a stock of every design of bolt in current use; a multiplicity of designs tends to increase this stock, roughly in proportion to the number of designs. It is unlikely that a bolt of one diameter will be mistaken for one of another diameter. On the other hand, where there are different lengths for bolts of a single diameter, or where the bolts have different shoulders, the probability of confusion in distributing the material is considerable. Nuts do not offer so much of a problem in this respect, since they are shipped with the bolts and usually last as long as the bolts.

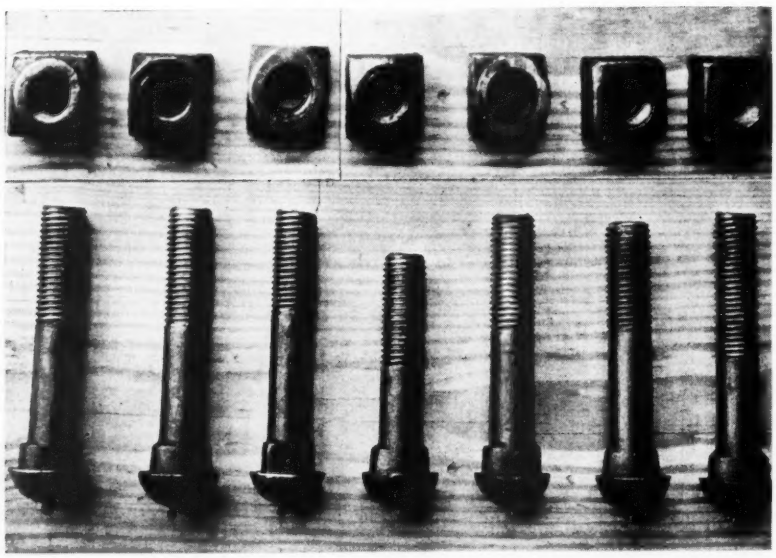
So far as an individual road is concerned, the only disadvantages of a multiplicity of designs or of frequent changes in design are the increased stocks that must be carried and the inconvenience arising through errors in distributing the joints and bolts. This objection does not apply to nuts, however, except where new designs require a change in wrenches.

The problem is not as simple as this, however, for track materials, including bolts and nuts, must be obtained from manufacturers, and if a multiplicity of designs increase his costs, they, of necessity, increase the price which the roads must pay, since a manufacturer must pass his costs along to his customers.

Die Costs

Bolts are made by the forging process, for which reason they require the use of dies. A bolt machine represents an investment of $50,000. The heading dies cost $50 a set; it costs $40 to change dies, including the overhead charge for two hours loss of production time. The blanks for the roller (threading) dies cost $50 plus the labor for cutting, which may be very high, and a separate set of roller dies is required for every diameter of bolt or change of pitch in the threads.

Every design of bolt requires a separate set of dies, regardless of whether the difference occurs in the head, the shoulder, the diameter or the length, or in any combination of these details. Theoretically, a change in length of as little as 1/16 in., even for bolts of identical diameter, requires a separate set of dies and, if the threads on the bolt are to be cut, these dies must be provided. Actually, new dies are not provided for increments of length less than ⅛ in., owing to the distortion of the end by the cutter and during the passage through the thread-rolling dies.



Although of the Same Diameter, These Seven Bolts Differ in all Other Details. Every Nut Differs in Design, but Will Fit Any of the Bolts

Nut Dies

Nuts are also made by forging, four separate operations being required, which necessitate the use of separate machines and a punch, a crowner, a piercer and a shaping die. After the stock bar is heated, the punch blanks out the block from which the nut is to be made. This block is shaped roughly by the crowner, after which the piercer punches out the slug to make the hole, and the shaping die finally forms the blank nut, which must then be sent to the threading machines for an additional operation. Every design and size of nut requires a separate set of punches and dies and the changing of these tools in the machines, the cost of each of which is substantially the same as for those required in making bolts. Although individual machines for making nuts

cost from $15,000 to $18,000, the combined investment approximates that for the bolt machines. In addition, variations in the design of the nut cause the scrap to range from 20 to 35 per cent of the original bar.

Added costs arise from the fact that it is not uncommon for a road to change its design for a bolt or nut, or both, long before the dies are worn out, in which event new dies must be provided. While the old dies are thus made obsolete, they can seldom be discarded since the road may at any time reorder bolts from the older design. As a result, one manufacturer is maintaining for current use 27 dies for ⅞-in. bolts, 23 for 1-in. bolts, 18 for bolts 15/16 in. in diameter and a comparable number of dies for the remaining 10 diameters which it is called on to make, some of these bolts of identical diameter differing by only 1/16 in. in length. Again, two manufacturers are making 120 designs of bolts in four sizes (diameters) for rail 100 lb. or heavier, while the number of designs for the older and lighter rail is still larger. Furthermore, it should not be overlooked that these dies are duplicated by all those companies among which a road distributes its orders.

Special Rollings

While the majority of the round bars used in making track bolts are of commercial sizes and are produced on commercial rolls, they must come from special rollings, since a tolerance of only 0.010 in. is permitted. If, therefore, a road designs a track bolt which requires a bar of other than commercial size, and this is done oftener than one might surmise, the mill must dress special rolls in order to make them, again adding to the cost of production.

Bars for nuts are flat and must be 1/16 in. thicker than the depth of the nut and 1/16 in. narrower than its width, these dimensions being necessary because the material is compressed in the crowner and spread by the piercer. For these reasons, many of the designs for nuts call for special, non-commercial sizes of bars, and this again requires special rolls at the bar mill.

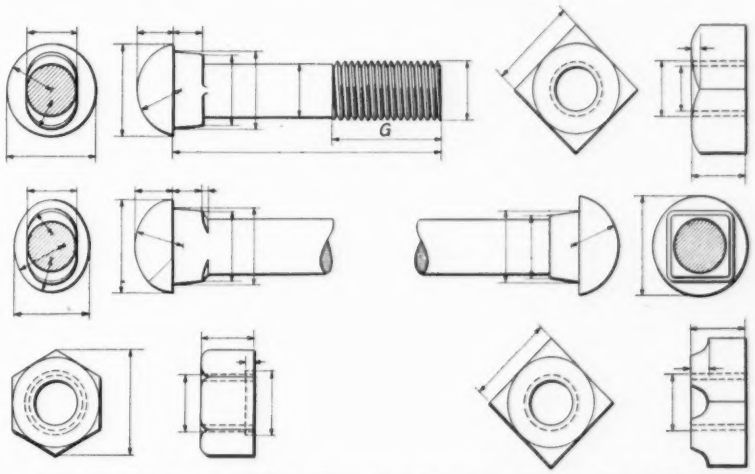
It is evident from the foregoing that a manufacturer of bolts and nuts is compelled to carry a large stock of round and flat bars for the various sizes of bolts and nuts which he is called on to make. Furthermore, the magnitude of this stock is greatly increased by the different physical and chemical requirements of the specifications under which these bolts and nuts are made. Thus while all bolts of a given diameter are made from the same size of bar, some manufacturers are compelled to carry as many as 15 to 20 kinds of bars of this diameter to meet the varied requirements of the specifications. In general, however, it is the multiplicity of sizes rather than the chemistry of the steel that increases the stock of bars for nuts that is required.

Another factor which increases the cost of production is the variation in the requirement for the fit of the nut. It is obvious that a hot-rolled thread cannot be a precise product, for which reason the guarantee of a finger fit is impossible. Neither can a No. 2 fit be guaranteed by any manufacturer who follows the ordinary process of making track bolts and nuts; yet he must meet the exacting requirements of the specifications if he expects to market his product. To do this places a burden on him that is not generally appreciated.

Exceptional care must be exercised in making the taps for threading the nuts, the limit of tolerance which can be allowed being 0.005 in. or less, approximately the precision requirements for a master gage, and since ordinary commercial taps do not meet these limitations, it is necessary for the manufacturer to provide highly specialized tools. Furthermore, while the necessity for these precision tools definitely increases the cost of manufacturing the nuts, this cost is still further increased by the fact that the fit demanded by one road differs from that for another, so that special sizes of taps, each differing minutely from the other, must be made for each road. Again, because of the small tolerances, the life of such a tap is amazingly short, as compared with commercial tools.

To obtain even this life, however, special steels are used and a special process of heat treatment, carefully controlled, is necessary to impart to the wearing surface a high degree of hardness combined with the requisite toughness. The bit of the tool must be hardened in brine, while the shank is quenched in oil. In the drawing process, taps for the U. S. standard threads must be reheated to a different temperature than those for the Harvey grip. In either case, however, both the temperature and the time of tempering are very important, a slight variation in either being sufficient to ruin the tap for the precise work required of it.

One of the surprising facts connected with the production of track bolts is that, while most orders are substantial, small orders are not uncommon, occasional orders calling for only a single keg. As an example, a road recently sent in an order for 1,020 kegs of bolts, representing 17 different designs in 5 different diameters. As it was necessary to change the dies for each design of bolts and nuts, this item of expense alone amounted to about $1.55 a keg. Another manufacturer recently received an order for 57 kegs representing 3 designs, while still another was called on to make 49 kegs to 3 designs, the die costs in these cases being about $4.20 and $5 a keg, respectively.



Any Variation in any of These Dimensions Requires a Separate Set of Dies

Another Example

Not long ago, an order was placed with a fourth manufacturer for 18 kegs of bolts of identical diameter but involving two separate designs. The manufacturer had dies for the bolts, but the designs for the nuts were different and as they had been changed since the previous order, it was necessary for him to make two sets of nut dies. In this case it cost the manufacturer approximately $9 a

keg to fill this order, in addition to the cost of the new nut dies. These examples illustrate the fact that for small orders the cost of changing the dies alone is sufficient to convert any normal profit into a loss. And bolts and nuts are selling today for less than $7.50 a keg.

It is evident from the foregoing that a manufacturer's costs are increased by the multiplicity of designs for both bolts and nuts; by the varying requirements for the physical and chemical requirements for the steel from which they are made; by the waste of raw material that is entailed by some designs of nuts; and by the duplication of dies by reason of the many designs. It is also clear that these costs are increased materially by the varying and exacting requirements with respect to the fit of the nut, and that substantial losses occur by reason of small orders.

Standardization?

In view of the high cost of production created by this multiplicity of designs and the wide variety of other requirements, the question arises logically whether it is practicable to standardize track bolts and nuts. It is recognized that different weights of rail require different lengths and diameters of bolts, and also that there are in service many joints for the older rail sections for which bolts must be provided as long as they remain in service.

So far as threads are concerned, they have already been reduced to two forms, and there is no apparent reason why the threaded length of the bolts cannot be reduced to a single standard for each diameter of bolt. Likewise, there appears to be no reason why the shape and size of the head cannot be reduced to a single design for each diameter of bolt. If this is done and especially if the button-head type is selected, a real economy can be effected, for it is extremely difficult to upset enough metal at a single blow to form many of the oval designs now demanded, particularly if they are accompanied by a deep heavy shoulder. In fact, a few of the current designs for oval heads are so difficult to form that they are only "roughed" on the regular bolt machines and must be finished on hand-fed headers, thus adding largely to their cost.

Primarily, the purpose of the shoulder is to prevent the turning of the bolt when the nut is tightened. There seems to be no reason, therefore, why this element of design cannot be reduced to a single form for each diameter. Certainly no defense can be offered for the multitude of exceedingly minute variations that now occur. Owing to the variation in length demanded by various designs of rail joints, a single length of bolt for any given diameter is scarcely possible; yet there is no reason why changes in length cannot be made in increments of ¼ in. or ½ in., depending on the diameter of the bolt, instead of 1/16 in. as at present.

Thirteen different diameters of bolts are now demanded, from ⅝ in. to 1¼ in. It should be possible to eliminate at once all bolts which differ by only 1/32 in. from the commercial sizes of bars, since the clearance of the bolt holes in the rails is sufficient to permit this to be done. All new rail could then be so drilled as to provide for increments in diameter in eighths of an inch instead of sixteenths as at present, This would immediately reduce the number of sizes to six, and as the smaller sizes are retired, this number would be still further reduced. In the same way, it should not be difficult to agree on a limited number of designs for nuts and on requirements for fit. Certainly, the present wide range of physical and chemical requirements is unnecessary and could be reduced without detriment to the service expected of the bolts.

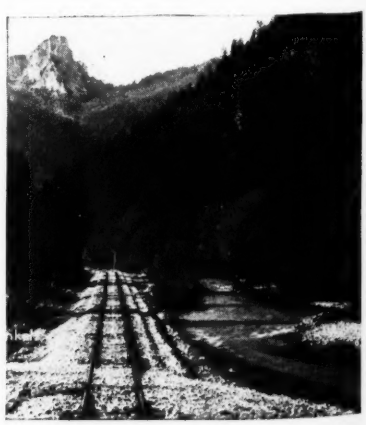
Trend in Design

Will the roads accept a single standard for track bolts and nuts? The situation with respect to bolt and nut design, particularly the latter, is probably more chaotic than for any other track material. Not only has there been no trend toward standardization but there has been no trend toward reducing the number of designs. In fact, the A.R.E.A. design, which represents the only important attempt ever made to standardize track bolts, is used so little that numerous manufacturers have never made dies for bolts of this design.

Shall this economic waste be allowed to continue unchallenged? Is there no middle ground between the present multiplicity of designs and rigid standardization? Preference with respect to certain features of design, such as button and oval heads; light, medium and heavy shoulders; square, hexagonal and "ideal" nuts; plain and recessed nuts; tight and medium fits for nuts; and other details, are so deep seated that it would appear to be almost impossible to obtain acceptance of a single standard for either bolts or nuts. Yet, within these classifications there is a multitude of minor differences that could be resolved to reduce the total number of designs to a relatively few, which would retain all of the fundamental features of the amazingly large number of designs now in use. This step would direct attention to the desirability of still further simplification.

Is complete standardization necessary for economy? It has been shown that the cost of making bolts and nuts is increased by the large investment which must be maintained in dies, many of which are never amortized; by the necessity for changing dies in the machines as orders are filled for one road after another; and by the duplication of dies at the different plants. If the number of designs can be reduced along the lines suggested, the manufacturer's investment in dies would be reduced accordingly and he would be able to amortize his dies within a reasonable time. The large inventory of bar stock now carried at all mills would likewise be reduced and the turnover placed on a more satisfactory footing. Likewise, it would become practicable to make up stocks in advance to care for small orders. In fact, every phase of the manufacturing operation from the stock room to the shipping room could be placed on a more economical basis.

If the designs can be reduced along the lines suggested, manufacturers will be able to effect the same economy in production that would be possible through concentration on a single design. At the same time, if these designs are chosen with due regard to retaining all of the fundamental features of those they replace, thus providing a suitable selection to meet the diverse needs, or desires, of the individual roads, they will more readily gain universal acceptance. Simplification in the design of track bolts and nuts possesses, therefore, all of the advantages of standardization, without its disadvantages.



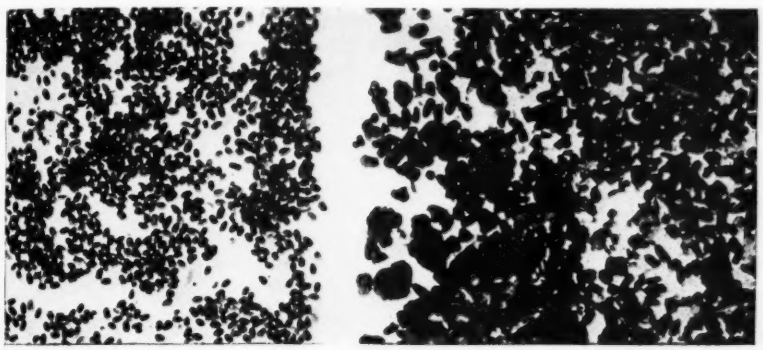
On the German State Railways in Bavaria

Recognizing Termite Infestation*

By W. H. Kirkbride

Chief Engineer, Southern Pacific, San Francisco, Cal.

THE most obvious indication that a building is infested with termites is the failure of some structural part. At the same time this is of rare occurrence, and ordinarily when it does occur, the failure results because some unusual load is applied. For instance, a safe moved upon a floor which has not previously carried much weight, may disclose ter- floor. More commonly, termites dis-



Fecal Pellets of Wood-Dwelling Termites (Mag. 2 Times), Dry-Wood Termites on the left, Damp-Wood Termites on the right.

close their presence by their own activities. Subterranean or ground-dwelling termites frequently build covered runways, or tubes, over foundations to reach wood above ground, as shown in the illustration.

These runways have the appearance of lines of dirt ¼ in. or more in width, extending up from the ground, or emerging from holes or mite attack by breaking through the cracks in concrete foundations and walls, in wavering lines, sometimes branching in various places and directions. Towers are sometimes built straight up from the ground as the insects search for food. When either the runways or the towers are broken open, live termites can generally be seen running up and down on the inside.

On the other hand, the type known as wood-dwelling termites, having no ground connections, must keep their waste products in the tunnels they construct in the wood, and when an excess of these products accumulates, an opening is made and they are thrown out. They will be found as little pellets, a group of which are shown in one of the illustrations, about 1/20 to 1/32 in. long and oval in shape, ranging in color from light tan or cream to dark red or even black, depending on the variety of termite, the kind of wood in which they are working and the moisture conditions.

Light-colored pellets, when very even as to size, and when, under a magnifying glass, are observed to have several grooves running lengthwise, indicate the presence of true dry-wood termites. On the Pacific

Runways of Subterranean Termites

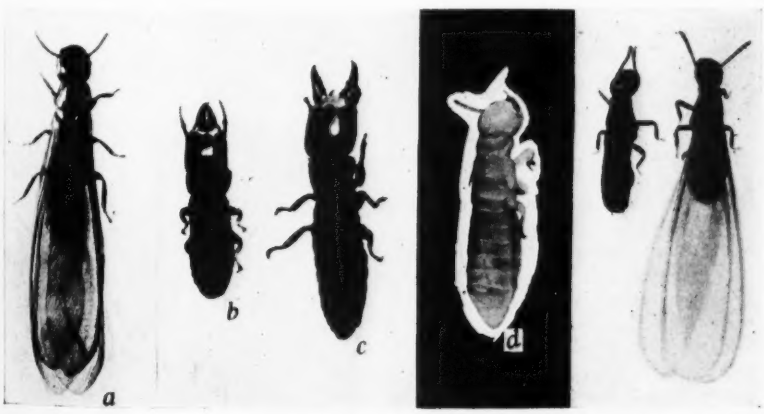
Coast, dark-colored, irregular pellets, especially if found close to the ground and in damp locations, indicate the variety known as damp-wood termites.

Termite infestation may also be discovered when the insects swarm. This is generally in the spring, but some termites, especially those on the Pacific Coast, swarm principally in the fall. When swarming occurs, the winged reproductive forms emerge from the nests in large numbers, usually hopping around for some time, then fly away in all directions with a jerky flight, changing direction every few moments.

When termites are seen swarming from a building or other structure, a careful inspection should be made, since swarming flights seldom occur until a colony has been established for several years and the population is fairly large.

When none of the foregoing signs of termite infestation have been observed, their presence cannot be determined definitely except by opening up suspected pieces of wood. If subterranean termites are present, a careful examination of all wood on or near the ground will usually re-

*This discussion was submitted for publication in the What's the Answer department in the April issue, but because of its scope, it is presented here as an independent article. For further discussion of this subject see page 235 of the April issue.



Dry-Wood Termites (Mag. 5 Times), (a) Winged Reproductive, (b) and (c) Soldiers, (d) Nymph. On the Right—Reproductives of the Ground-Dwelling Termites

sult in the discovery of their runways.

Sometimes subterranean termites enter the wood of the structure by means of cracks in foundations, in which event they do not build visible runways. When such an entrance is used, the point of attack is difficult to locate. If damage appears in the upper part of a building and no runways are found, it is well to sound the mud sills, sills, studding, etc., carefully with a hammer or poke them with a sharp knife or ice pick. An investigation of this kind may disclose tunnels and indicate the point at which termites have entered the building.

It is recommended that those who are interested in obtaining more detailed information on this subject and on the protective measures to be taken when termites are found, read Chapters 46, 47 and 48 of Termites and Termite Control, published by the University of California in 1934, which book is the result of a comprehensive study made over a period of five years by the Termite Investigations Committee, a Pacific Coast organization, the membership of which included the engineering staffs of the railways, oil companies, public utilities, some representatives of the sugar and lumber industries and of the building departments of certain cities, and scientists, the latter being chiefly members of the faculty of the University of California.

Why Foundation Piles Heave*

By J. F. Seiler

Engineer, Service Bureau, American Wood Preservers' Association, Chicago

PILES already driven do not always heave when additional piles are driven in the group or adjacent to the pile or piles in question, since the phenomenon of heaving does not occur to a significant extent in the majority of cases. Heaving does take place, however, under certain conditions of soil, character of the strata encountered, the penetration of the piling and the spacing at which they are driven. Probably heaving is also affected by the manner or the order in which the group of piles is driven. For example, whether the driving is started at the center of the group and progresses outward, or vice versa.

The Bulb of Pressure

When a pile is driven into the soil, the surrounding material is compacted, and experiments have shown that lines of equal pressure in the soil form contours, the general shape of which is a bulb, called the bulb of pressure. By means of the bulb of pressure thus developed, any load imposed on the pile is distributed to some lower stratum or strata, which is capable of sustaining the load so imposed.

When an adjacent pile is driven, provided the spacing is not too great, its bulb of pressure will extend to and exert force against that of the previously driven pile or piles. The pressure thus exerted develops or brings into action a vertical upward component of the forces in the two bulbs. This upward component tends to lift the pile and if conditions are favorable, heaving results. The amount of the heaving that takes place depends largely on the penetration of one pile compared to that of the one that is causing the disturbance. Other things being equa, the degree of heaving may depend to some extent on the weight of the pile involved. Other factors are of far greater importance, however.

For instance, the weight or mass of a pile is an important factor in its driving. It is well known that as the mass increases, there is an accompanying waste of hammer energy, which may be accounted for in the heat generated, the deformation that occurs in the pile, the vibration of the soil and other factors. Where a group of heavy piles is driven, more energy is required to drive them to a given bearing than for a similar number of lighter piles. Consequently, it is clear that a correspondingly greater amount of energy, which is not applied in useful work, is dissipated laterally into the surrounding soil. This, in turn, tends to increase the upward vertical component of force which causes the piles to heave.

This increment of upward force is compensated for to some extent by the weight of the heavy piles, so that on the whole, as between heavy and light piles, the conditions tending to create heaving are probably balanced. Heaving might be considered aggravated if, in a single group of piles, some are of wood while others are heavy, such as iron, steel or concrete. This is a case that so rarely occurs, however, that it does not require discussion.

No Significant Difference

From the foregoing, it may be concluded that, where the soil is uniform and the penetrations of comparable groups of piling are equal, there will be no significant difference in the tendency to heave, whether timber or concrete piles are involved. It is believed that experience bears out this conclusion.

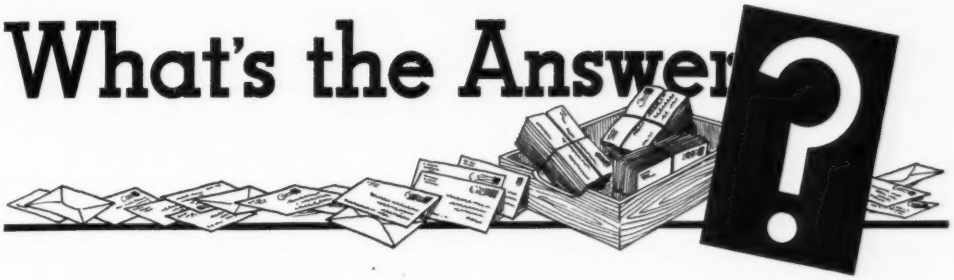
In this connection, it is important to note that when timber piles are driven in a foundation, assuming that the soil is uniform to the full depth of the penetration, a considerably greater depth of penetration will be obtained to secure the same bearing value or if the same amount of hammer energy is expended on them, as compared with a hypothetical group of steel or concrete piles driven in the same place. There is also some evidence that there will be less tendency to heave in the wooden piles. In other words, relative penetration is a factor of importance in unstable soils where danger of heaving exists.

Soil conditions are more responsible for the heaving of piles than any other factor. Since there is such a diversity of soils and of their characteristics, even on individual projects, the question as to whether one pile will heave more than another cannot, in general, be answered without making a large number of assumptions. Furthermore, the most careful assumptions and the most logical reasoning may be completely upset by the actual results obtained in the driving. The reason for this is that the whole question of piles and pile driving is notable for the obscurity in which it is developed.

Central Station, Chicago

*This discussion was submitted for publication in the What's the Answer department in the March issue, but because of its scope, it was withheld for publication here as an independent article. For further discussion of this subject see page 177 of the March issue.

What's the Answer?



Draining Hot Water Systems

Should hot water heating systems be drained when they are shut down for summer? Why?

Should Be Kept Filled

By E. M. GRIME
Engineer Water Service, Northern Pacific, St. Paul, Minn.

When a hot water heating system is first installed, it is a good plan to flush it out as thoroughly as possible with water under pressure, to get rid of the loose mill scale, pipe cuttings, lumps of grease and other foreign matter which may have accumulated during construction. The system should then be filled with the cleanest water available and thereafter never drained unless necessary for the purpose of making repairs. A limited amount of water must be added at the top of the system from time to time to make up for the slight losses caused by leakage or corrosion.

It may often be noticed that when the water gets low in the system, as indicated by the gage at the furnace, if water pressure is applied at the low point, a rush of gas will occur when an air cock is opened on the highest radiator. This gas can be ignited and will burn for a few moments with the typical blue flame of hydrogen. It is evident from this that the dissolved oxygen, together with the air that was entrapped in the radiators and piping as the system was filled, is responsible for the slight corrosion which has occurred. The oxygen combining with the iron to form rust, liberates hydrogen and this eventually rises to the highest point of the system, where it may be drained off.

The water acts merely as the vehicle for carrying the heat and when it has been freed of its surplus (dissolved) oxygen, it will cause less corrosion in the piping, for which reason it will be more suitable than fresh water. If there is any temporary hardness in the water used for filling the system, there will eventually be some accumulation of sludge at the low point during the first season of operation. It will be advisable, therefore, to drain off about 10 to 15 gal. of water from the bottom and replace this to keep the system completely filled during the time the plant is out of service. If the system is drained completely during the summer, air will take the place of the water and the free oxygen combining with the moisture left in the pipes will cause considerable corrosion.

From the foregoing it is evident that it is a mistake to drain a hot water heating system at any time when it is not absolutely necessary to do so. If for any reason it must be drained, the system should be refilled as soon as practicable.

Draining Causes Corrosion

By E. B. PLANT
Assistant Engineer, Canadian Pacific, Montreal, Que.

Hot water heating systems should not be drained when they are shut down for the summer. In an empty system, condensation will accumulate in the water spaces of the boiler and piping in sufficient quantity to keep the surfaces moist. This will result in an accumulation of rust that will tend to block the pipes and shorten the life of the equipment. The only reason for draining a hot water treating system is to clean out the sludge and dirt. This accumulates generally during the first season of operation from excess pipe-joint compound used during construction, sand from the radiators, etc. Once this is removed from the system, it is detrimental to change the water too frequently.

The reasons for this are obvious. In localities where the water is very hard or alkaline, frequent changes of the water in the system result in an accumulation of hard scale on the interior of the piping and on the heating surfaces of the boiler. This decreases the heating efficiency of these surfaces. Again, where the water is very soft or acid, the inside surfaces of the system are exposed to pitting and corrosion.

As a general rule, it is good practice to clean the system thoroughly

Send your answers to any of the questions to the What's the Answer editor. He will welcome also any questions you wish to have discussed.

To Be Answered in September

1. *Should the section gang assist a rail gang when laying rail on its section? If so, in what ways?*
2. *Where a single pile in a ballast-deck trestle fails, should it be redriven? Why? If not, how can it be replaced? If so, how should it be done?*
3. *Should new joint bars be applied when welding rail ends? Why? If so, when should they be applied? Why?*
4. *What provision should be made for fire protection and fire prevention at small stations?*
5. *Is it preferable to crib across a washout with ties or to drive a temporary trestle? Why? If the former is it practicable to salvage the ties when the filling is done?*
6. *How does one go about making repairs to a broken discharge line? A suction line? Does the method differ in swampy ground?*
7. *Should the standard for tie renewals be less rigid for branch lines than for main lines? Why? If so, how should it compare with that for main lines?*
8. *Where only a few rivets are to be replaced, should they be driven by hand? Under what conditions is it worth while to set up a compressor and use a pneumatic hammer? Why?*

several times immediately after construction and again at the end of the first season of operation. At the end of each succeeding season enough water should be drained from the lowest part of the system to insure removal of the sludge and dirt, which will be indicated when the water runs clear. This water should then be replaced, when the plant will be ready for the next season's operation.

Where practical, it is also desirable to run a light fire about once a month to dry the exterior heating surfaces of the furnace and the interior of the smoke flue. This prevents an accumulation of condensation, with consequent rusting of the heating surfaces and flues.

Draining Is Detrimental

By E. L. Cales
Supervisor of Water Supply, Chesapeake & Ohio, Hinton, W. Va.

Based on experience with hot water heating systems, I believe that they should not be drained when they are closed down for the summer. It is certain that where this is done, considerable corrosion takes place and the dry scale that forms on the interior of the boiler and pipes is detrimental to these surfaces, while it tends to loosen and move as the water flows when the plant is returned to service the following winter. The result is that it gets into the small pipes and stops them up; it also gets under the valve seats where it may cause much trouble, sometimes being in sufficient quantity to block the valves.

Depends on Water Used

By G. A. Rodman
General Supervisor of Buildings, New York, New Haven & Hartford, New Haven, Conn.

The best method to follow depends somewhat on the quality of the water used in the system. If there is considerable sediment in the boiler and pipes, the system should be drained in the spring and refilled with clear water. There will be much less interior corrosion if the pipes are full of water than if they are left empty with moist air inside of them. If a supply of pure water is available, I can see no reason for draining the system except to blow off water until it runs clear, after which the discharged water should be replaced. Another reason for keeping the system full is to eliminate the danger of starting a fire in the fall with the boiler empty, and the probability that it will be cracked. Furthermore, if the cellar is damp, an occasional light fire during the summer will be beneficial because it will dry out the boiler and smoke pipe.

Maintenance of Turntables

What details should be given particular attention in the maintenance of a turntable? Why?

Lubrication Important

By Geo. H. Tinker
Bridge Engineer, New York, Chicago & St. Louis, Cleveland, Ohio

Since a turntable is a piece of machinery with moving parts, lubrication is the most important detail in its maintenance to avoid wear, permit easy operation and insure low power consumption. If the center is of the roller type, the rollers or cones travel in a reservoir of oil, which should be kept full of oil of a medium consistency that will not congeal in cold weather. The same grade of oil can be used in the bearings of the end truck wheels, whether these are straight axle bearings of the balanced table or roller bearings of the three-point-bearing type.

If the center is of the disc type, the lubricant should be a soft cup grease which will not harden in winter or run in summer. Graphite cup grease fulfills these requirements. It should be applied by means of a grease gun once a year or oftener, at which time the old grease should be flushed out and the oil grooves and compression cups filled with fresh grease. Between applications, the compression screws should be given a turn once a week and the grease and oil cups filled when empty. It is good practice to jack up the table about once a year, before cold weather, to examine all of the bearings for signs of wear and to insure that they are clean and have a liberal supply of fresh lubricant.

Next in importance, the table should be kept in proper adjustment. The circle rail should be level. The axles of the end-truck wheels should be truly radial. If the trucks become slued the wheels will act as a brake and cause the table to turn hard. In this connection, the operator should be taught, by drastic methods if necessary, to use the brake to retard and stop the table. If left to his own devices he will generally accomplish this by reversing the motor, thus causing damage which someone else must repair.

When a balanced table begins to "ride hard" because of excessive loading, the first relief is to remove shims from between the end trucks and girders and add shims under the center. This changes the relation between the table rails and approach rails and increases the drop when the locomotive comes onto the table. When this drop is greater than 1½ in., the table is too weak for the loads it is carrying and should be converted into a three-point bearing.

Finally, the structural parts should be kept clean and well painted. Every locomotive coming onto the table drops a few cinders. When they are washed down with hot water, the combination affords an effective means of first destroying the paint and then corroding the steel.

Recapitulating, the principal details of maintenance are lubrication, adjustment and cleanliness. Other details include keeping the pit drainage open as well as the drainage space between the circle rail and the wall. Frequent inspection with prompt care and adjustment will result in long life and satisfactory operation, while neglect will bring increasingly frequent complaints of difficult and costly operation and, eventually, failure to function.

End Adjustment Is First

By W. C. McCready
Assistant Engineer, Chicago, Burlington & Quincy, Chicago

The most important factor in maintaining a turntable is keeping the ends of the table rails and the ends of the surrounding rails in proper adjustment with respect to height and clearance. If this is not done, more damage can be done to a turntable than from any other one neglect in maintenance. The reason for this is that the pounding of modern locomotives can result in serious damage within a short time, involving repairs to the structural steel and bearings and probable delay in moving the locomotives.

We take the following steps to eliminate trouble from this source: (1) All balanced tables are counterweighted on one end, if power operated; (2) notices of instructions prohibiting the entering of a locomotive on the unweighted end of the table, except in case of necessity, are posted

on the turntable; (3) the table rail at the weighted end and the ends of all house and approach tracks must be maintained at the same height; (4) the clearance between the ends of the table rails and those of the house and approach tracks must not exceed a specified amount; (5) where heavy locomotives are turned, a steel end tie is used on the table, and a heavy curb plate of channel construction is placed on the curb timber under each rail end of house and approach tracks; and (6) on continuous, or three-point, turntables, we take the same precautions, eliminating the counter-weights and the instructions with respect to entering the table.

As a final precaution, on balanced turntables, the clearance between the carriage wheels and the top of the circle rail is maintained at the absolute minimum, this being determined by test with the heaviest locomotives in use on the line involved.

Many Details

By F. R. Ramsey
District Engineer, New York, Chicago & St. Louis, Frankfort, Ind.

Turntable rails and those leading away from it should be maintained at the same elevation. As the ends of these rails become battered they should be built up as necessity requires. We have found that a pair of joint bars bolted and welded to the rails at their ends are of much help in retarding this action. A distance of 1 to 1½ in. should be maintained between the rails on the table and those on the circle wall. The rails on the table and on the approach and house tracks should be well anchored to avoid movement and the disturbance of the clearance gap.

Settlement often occurs in tracks leading away from the table. This results in "cocking" the ends of the rails on the circle wall, bringing them above the table rails. When this occurs, the tracks should be surfaced and leveled.

The circle rail should be perfectly level so that the table will turn easily. If supported on wooden ties, they should be tie plated and renewed as soon as they show signs of decay, to insure a uniform bearing. If metal ties are used, the clips should be kept tight and loose ties attended to promptly. Circle-rail joints should be welded in order to give a smooth surface.

In tables of the balanced type, the truck wheels should be maintained at the same distance above the circle rail at both ends of the table, this distance being kept to the minimum but sufficient to prevent the heaviest locomotives from bearing too heavily on the circle rail, particularly if the table is light for the loading imposed upon it. The center bearing and truck bearings should be inspected periodically and kept clean and well lubricated. About once a year the table should be jacked up and the center taken apart and inspected for worn parts.

End Trucks Most Important

By L. G. Byrd
Supervisor of Bridges and Buildings, Missouri Pacific, Poplar Bluff, Mo.

End trucks require more frequent attention than other parts of a turntable, this being particularly true of tables that are too short to balance the locomotives. These tracks should be maintained to the highest standard to reduce friction and, therefore, the power required for turning. Examination should be made periodically of the diaphram in the carrying girders for distortion, loose rivets, cracked angles and other forms of deterioration, as a failure of this part will put the table out of commission, since such a failure usually results from buckling of the web.

In some cases the center requires close attention, especially where water is allowed to accumulate in the pit to an elevation above the center bearing. This will float the oil out and cause damage to the rollers and raceways not only by elimination of the lubrication but by reason of sand and other grit that find their way into the center. This trouble usually occurs at points where proper drainage is not or can not be maintained. In the event of trouble of this character, the table should be raised, the center should be opened and thoroughly cleaned and new oil applied.

Laying Heavy Rails Tight

Is it practical to lay rails of 100-lb. and heavier section tight? What are the advantages? The disadvantages?

Would Control Expansion

By E. L. Banion
Roadmaster, Atchison, Topeka & Santa Fe, Independence, Kan.

For years it has been the trackman's dream that some day the expansion gap between rail ends will be eliminated, possibly by laying the rail tight. If this can be done, it will reduce, if not eliminate, rail batter, reduce joint-bar wear, loose bolts and low joints, and greatly improve the riding condition of the track. Success will depend on several factors, however, the first of which is that to prevent chipped ends, the rail should be heat treated and beveled. Second, a ballast section sufficient to hold the track in line during extremely hot weather must be provided. Third, the rail should be laid at a time when the temperature is close to the mean between extremes for the locality, for rail laid tight in the hottest weather is about as objectionable in the winter, because of open joints, as winter-laid rail is during the summer, because of difficulty with line.

Speaking generally, it has been my experience that rail laid tight develops a number of disadvantages. Unless the track is well maintained and the ballast section is heavy there is always danger of sun kinks, which have been known to cause serious accidents. Tight rail cannot be lined and surfaced safely during the midday heat of the summer months, while it is extremely difficult to keep tight rail in good line during hot weather.

Several years ago I was connected with a project on which considerable effort was expended to insure that the rail was laid tight. During the following summer, sun kinks became numerous and curves moved out of line to the extent that train movements became hazardous. Finally, we were compelled to restrict speed until the joints could be opened enough to relieve the expansion strains. From this and other experience it is my belief that it is better to lay the rail with correct expansion and control the movement to avoid "bunching," by applying anti-creepers.

Considerable Advantage

By Chief Engineer

Based on experience I find that considerable advantage in reduced joint maintenance and in minimized rail batter can be obtained by laying rails of the heavier section tight under certain conditions and with certain types of fastenings. This opinion is based on observation over an extended period, of long sections of track in which the rails were laid practically tight at temperatures only

slightly above the freezing point.

Prior to the change in the table of recommended expansion allowance, published by the A.R.E.A. in 1931, I felt that the recommended allowance provided too large a gap, in some cases. With the adoption of the changes I believe that, theoretically, the recommendations are about correct. Practically, however, I am sure that liberties can safely be taken with them under certain conditions.

Use Anti-Creepers

By G. B. McClellan
District Roadmaster, Texas & Pacific, Marshall, Tex.

Rail laid tight in cold weather will inevitably be kinky in hot weather and may buckle, for which reason it cannot be disturbed for lining and surfacing, thus adding to the hazard of operation and the difficulties of maintenance. The only advantages are the prevention of chipped ends and the elimination of open joints in winter. These objectives can be attained, however, by using a sufficient number of anti-creepers to maintain the expansion uniform. Rail can be laid tight at 100 deg., but it should be fully anchored to prevent bunching over-night or during rainy or cloudy weather. Before efficient anti-creepers were available, there was some logic in laying rail tight to prevent open and stripped joints in cold weather, and to some extent creeping. These advantages, together with others, including the prevention of such troubles as sun kinks and buckling, are now gained through the proper use of anticreepers.

Gage Rods and Tie Plates

Where double-shoulder tie plates are in use, is there any necessity for gage rods? If so, under what conditions?

Does Not Recommend Them

By R. E. Patterson
Division Engineer, Lehigh Valley, Easton, Pa.

I do not recommend using gage rods with double-shoulder tie plates. There may be cases of excessive curvature, such as in colliery or other industrial tracks, where they can be used to advantage. Under ordinary conditions, however, it is not economical to use gage rods with double-shoulder tie plates. Under ordinary conditions, where the ties are good, or even in fair condition, there is certainly no need for gage rods. If the ties are so poor that gage rods, in addition to double-shoulder tie plates, are needed to hold the track to gage, the possibility of derailment is so great that the condition of the ties should be improved.

They Are Still Needed

By District Engineer

So far as the inside shoulder on the tie plate is concerned, I fail to see why this, in itself, will have any influence on the need for gage rods. Gage rods came into use long before tie plates, to hold the rail against outward thrusts of the wheels, particularly on curves. We have also used them in connection with shimming where excessive heaving occurs. With the advent of the tie plate, it was expected that the need for gage rods had passed. Experience proved that this was not so. When the outside shoulder was added, we were sure that they would no longer be needed, but again we were wrong.

The shoulder that has now been added is on the inside of the rail, so that it does not itself offer any resistance to outward thrusts. On the other hand, double-shoulder tie plates may be larger and heavier than those having a single shoulder, and many of them are secured to the tie with independent fastenings, for which reasons they are more resistant to the forces which tend to widen the gage. In some cases, therefore, they may eliminate the need for gage rods.

Needed As Before

By W. H. Sparks
General Inspector of Track, Chesapeake & Ohio, Russell, Ky.

Gage rods are used to resist outward thrusts which tend to spread the rails, for which reason they are more generally used on curves. I presume every trackman has used them with single-shoulder tie plates at some point where it is difficult to hold gage. The second shoulder on the tie plate offers no resistance to outward thrusts and, therefore, serves no purpose with respect to holding the track to gage, its advantages being entirely different. If track shows a tendency to spread, double-shoulder plates are no more helpful than the single-shoulder type, and the need for gage rods is the same in either case. Double-shoulder tie plates are generally larger and heavier, and may thus have some indirect, effect in holding gage.

Brown Metallic Film on Paint

What causes the brown or gray metallic film which is sometimes found on paint on both steel and wood surfaces? How can it be avoided? How removed?

Occurs with Lead Pigments

By Geo. A. Belden
Architect, Central of Georgia, Savannah, Ga.

These discolorations can be, and frequently are, caused by the presence of sulphur compounds, and are most likely to occur on paints containing lead pigments. The sulphur may have its origin in fumes containing sulphur gases, which come into contact with the paint surface, or it may be due to sulphides of other metals, particularly of zinc, in the paint.

The film will most generally be found to be sulphide of lead, however, in which case it can easily be removed by washing with hydrogen peroxide. Not infrequently, such films will appear during dry weather and disappear entirely after a hard rain. This is due to the fact that lead sulphide is somewhat unstable and tends to oxidize into lead sulphate. The obvious way to avoid the formation of such films on paint is to avoid the use of paints containing lead pigments when it is known that the local conditions are of such character that they will cause sulphur to deposit on the surface.

Are Not Permanent

By Master Painter

Discolorations which impart a brown or gray metallic appearance to the surface of paint are almost invariably caused by a deposit of lead sulphide. The only constituent of the

atmosphere which will produce lead sulphide is sulphuretted hydrogen (H_2S), a product of organic decay. It is particularly noticeable in sewage and decaying fecal matter, but is often encountered in oil districts, at refineries and around coal mines. It is this gas which gives spoiled eggs their aroma.

Lead sulphide is not stable, for which reason the discoloration is seldom permanent. Not infrequently, it will form over considerable areas of the paint surface during dry weather and disappear completely after a rain. It can be easily removed by the application of hydrogen peroxide, which oxidizes the sulphide to produce a sulphate. Since there is little chance of eliminating the gas from the atmosphere, there is not much that can be done to prevent the discoloration, although it can be removed in the manner described, if necessary.

Causes of Failure in Crossties

What are the most common causes of failure in crossties? To what extent and in what ways can trackmen eliminate or retard these failures?

Can Extend Life

By H. E. Herington
Section Foreman, Minneapolis & St. Louis, Jordan, Minn.

Although there are some forms of failure which are beyond the control of the trackman, the things that he can do to extend the life of ties include proper tamping both inside and outside of the rail to eliminate broken ends and centers. He can exercise care in adzing to avoid exposure of untreated wood and apply hot creosote to all adzed surfaces. A careful foreman will not allow picks and shovels to be used for pulling in ties, but will require the use of tie tongs. He will see that the wood is not bruised by sledges or mauls, but will use a lining bar or spacing jack to shift ties. When gaging, he will plug the old hole and redrive the spike instead of driving it in a new place. In short, he will avoid in every practicable way the bruishing of the wood or the exposure of untreated wood because these are the most common ultimate sources of failure.

By Improved Handling

By G. B. McClellan
District Roadmaster, Texas & Pacific, Marshall, Tex.

Modern supervision of inspection and treatment may be said practically to have eliminated the basic causes of tie failure—poor varieties of wood, improper manufacture, insufficient seasoning and poor treatment. While these causes are not under the control of the trackman, they have in the past accounted for many failures; yet some causes of failure remain which are under their control.

Treated ties should never be bruised or punctured, the most objectionable of these abuses being the use of picks or shovels, instead of tongs, for pulling them into the track and striking them with mauls to bring them into position for spiking. Nipping a low spot in the track by placing a claw bar on lining bar under the end of a tie crushes the wood over a small area and results in decay long before the tie fails otherwise. A single blow of a maul on the end of a tie will invariably prepare the way for premature decay and result in a cavity in the end of the tie within five or six years. A tie can be pushed endwise with a bar more quickly and easily than it can be driven.

Tie plugs should be driven down fully without shattering. Careless blows and partly-driven plugs open a fertile field for decay. A tie plug is inexpensive, costing only about one-half cent, but it will save a dollar in the life of the treated tie if applied properly.

Adzing should be kept to the absolute minimum necessary to provide an even bearing for the tie plates. When adzing in connection with gaging or to straighten canted rails, care should be exercised to cut to a uniform depth to secure an even bearing. Tie plates should not be driven forcibly under the rails, as this will bruise the wood. The rail should be sprung with a jack, so that the plates will enter freely or at most by light driving.

When removing ties that are to be reused, they should be handled as carefully as new ties. They should not be driven off their seats with mauls or pulled out with picks or shovels. All spike holes should be plugged, even though the ties are to be turned over when reapplied. In the handling and use of ties, the trackman finds one of his greatest opportunities to effect a saving for his railway.

They Control Many Factors

By W. E. Tillett
Assistant Foreman, Chesapeake & Ohio, Maysville, Ky.

Crossties fail from splitting, damage by derailment, fires, seasoning under improper conditions, insufficient treatment, defects in the wood such as cross grain, shakes, etc., and because of lack of tie plates or plates of insufficient area, but these causes are not within the control of the trackman. There are, however, a number of causes of failure for which he must accept responsibility if he does not do his part to eliminate them.

While center-bound track accounts for only a minor percentage of the total failures, it can become a real factor if not corrected. Conversely, tamping at the ends but not under or inside of the rail has caused many sound ties to break, and these failures occur more readily if the ties have been weakened by spike cutting. Ties, and this applies particularly to treated ties, should be handled carefully, from the unloading operation until they are spiked and tamped in place in the track, since practically every form of mishandling is a potential cause for decay.

Bruised wood decays quickly. For this reason, when unloading, care should be exercised not to drop the ties so that they will be bruised. For the same reason, they should never be hammered with spike mauls or sledges to straighten them in the track or to move them endwise; a spacing jack or a lining bar will do this without damage. They should not be dragged in with picks or shovels; tie tongs are just as effective and do not expose untreated wood. Excessive spiking and the driving of tie plates under the rail are also avoided by the careful foreman.

Another form of failure often found on heavy-traffic lines, especially at soft spots, is the rounding of the corners of the ties by frequent or careless tamping, as a result of which the bearing on the ballast is greatly reduced. Such ties should be removed and, if sound, turned over and used in minor sidings.

They Can Do Much

By C. D. Turley
Chief Tie Inspector, Illinois Central, Chicago

Primarily, the functions of the crosstie are to support passing wheel loads and, through the application of spikes, to hold the track to gage. Assuming that the ties have been manufactured properly and treated with an efficient preservative, there is

much that trackmen can do to conserve their life. The ordinary causes of failure are decay, mechanical destruction, splitting and spike killing. When untreated timber is exposed by adzing or in other ways, hot creosote should be applied to the exposed surface. In no case should picks or other tools with sharp points or edges be used in handling ties. All spike holes should be plugged with treated tie plugs to prevent moisture entering the holes.

Mechanical destruction can be held to the minimum by keeping the track in good surface and alignment. As a further aid, track conditions should be as nearly uniform as practicable, that is, no tie should be called on to carry more than its share of the load. Center-bound track, untamped ties, loose tie plates and similar irregularities increase mechanical action which leads to ultimate tie destruction.

Splitting is a natural defect of wood over which the trackman has little control. Certain things should be avoided, however, such as the placing of ties under joints, which show indications of splitting. Spikes should never be driven in the direct line of splits, even if this makes it necessary to reverse the spiking.

Excessive spiking and adzing greatly shorten the life of a tie, and these, perhaps, have been the most common errors of the trackman. Adzing should be kept to the minimum and spikes should never be withdrawn and redriven, or additional spikes driven, unless absolutely necessary. Quite frequently spikes are driven in connection with derailments, shimming, bracing, etc., when this could have been greatly reduced or avoided altogether.

Chamfering New Rail Ends

Should the ends of new rails be chamfered? Why? Should this be done when it is laid or later? Why? If later, how much?

They Should Be Chamfered

By W. L. Roller
Division Engineer, Chesapeake & Ohio, Columbus, Ohio

For several reasons the ends of new rails should be chamfered. In sawing the rails at the mill, the edges are sometimes left somewhat ragged and rough. These jagged edges, particularly on the tops and sides of the head, can easily be removed by grinding or filing, after which they are not so likely to chip under traffic. I believe that rails should be chamfered on the top and also on the gage side of the head immediately after laying. While it may be necessary to repeat the chamfering because of the rolling-out action of the wheels on the metal, it is my thought that the rails should be slotted before any traffic passes over them, as the battering action of the wheels is more severe during the first few days than at any subsequent time.

There is considerable difference of opinion as to the amount of metal that should be removed in chamfering. It is my conviction, however, that the less metal removed the better, if the purpose of keeping the rail ends from coming together and overlapping is accomplished. As a fair average, I would say that the cut should not be greater than 3/32 in. horizontally or 3/16 in. down. This is sufficient to prevent the usual overflow of metal onto the abutting rail and the subsequent chipping when the rails contract and pull apart. By careful and methodical slotting, the chipping of rail ends can be reduced to a very low point.

Chamfering, or slotting, can be done more easily when the rail is first laid, as the expansion is uniform and the corners are more easily ground off. To wait until later necessitates additional work because of the cold rolling of the metal by the wheels and the unequal expansion. Again, if the rail ends have been hardened by heat treatment, there will be added difficulties of grinding. Chamfering is of such importance that consideration should be given to repeating the operation if the ends of the rail show a tendency to close up under traffic.

Depends on When Laid

By P. O. Ferris
Assistant Engineer, Maintenance of Way, Delaware & Hudson, Albany, N. Y.

New rail should be chamfered when laid and, although every joint may not need it, they should all be chamfered, since the cost is not large and to do so provides a factor of safety against chipping. No matter how excellent the joint maintenance is with respect to support, expansion, tightness of bolts, drainage, surface, etc., there will be end flow of metal on the running surface of new rail until such time as the surface becomes case hardened by the cold-rolling action of the wheels. If this metal flows to contact abutting rails, it will chip or break off, leaving an irregular surface which will result in batter.

On tangents, it is without question that the life of the rail depends on the life of the joint and until the development of welding to build up the rail ends, rails were removed because of end failure, which would otherwise have had many years of service life. It is not to be expected that batter can be eliminated entirely, but it can be minimized by chamfering and the time postponed when it becomes necessary to build up the ends by welding or to remove the rail finally.

There is considerable difference of opinion among maintenance officers as to the proper time to chamfer. I believe that this depends on the season when the rail is laid. If it is laid in the summer, without expansion gaps, I believe that it should be chamfered immediately, for any metal that flows will contact or overlap the abutting rails, causing chipping and subsequent batter, unless this is prevented by chamfering.

On the road with which I am connected, new rail is laid during the winter. Although we use a type of track fastening that permits considerably less than the theoretical expansion, the temperature is generally so low that the expansion gap that we do allow is at the maximum. For this reason, we do not chamfer the rail immediately, allowing it to become somewhat case hardened by cold rolling, and the metal that does flow at the ends is allowed to accumulate, but not to such an extent that chipping will occur. When this metal is removed by chamfering, the rail is case hardened and further flow of the metal is not rapid.

Needs Further Study

By W. H. Sparks
General Inspector of Track, Chesapeake & Ohio, Russell, Ky.

There is now little difference of opinion as to the value of chamfering, but considerable as to the best time to do it. Every one who has observed new rail is aware that for some time after it is laid, there is a decided flow of the surface metal until the cold-rolling action of the wheels case hardens and thus stabilizes it. If this flowing metal is not watched closely, it will result in chipping and subsequent battering of the rail ends. On the face of it, this would indicate that the chamfering

should be done immediately, or at least shortly after the rail is laid.

I am not yet convinced, however, that we would lose any of the service life of the rail, or increase welding costs, if we waited some time before the chamfering is done. If done immediately, there is certain to be considerable flow of metal over the edge of the slot, and there may be enough to require a second slotting to remove it. It is beyond question that we will have to watch the rail quite closely to insure that after a lip is formed, the expansion does not close up and shear it off, thus chipping the rail, but with plenty of anti-creepers this can usually be avoided. This is a subject that will bear further study before we are in a position to give a final answer with assurance that we are right in the matter.

Value Twofold

By G. M. Cornell
Assistant Engineer, Chesapeake & Ohio, Richmond, Va.

I refer to the article, and particularly the charts, by C. H. R. Howe on page 290 of the May issue, which describes a test to determine the value of heat treatment and chamfering of rail ends. The value of chamfering is twofold. First, it reduces the amount of chipping and, as a corollary, of spot welding. Where welding is done out of face, this means a reduction in the amount of emergency welding to care for seriously chipped joints. With a spot-welding program, the number of joints to be worked each year will be somewhat reduced.

A second benefit is the reduced welding time. In general, the cost of a weld is roughly proportional to the amount of metal applied. Joints that require only the forging of the head can be completed at the rate of four or five per welder hour, at a cost of about $0.30, while those requiring the application of a large amount of metal may take enough time to run the cost to $1.25. The average lies between these extremes.

Considering two joints of equal batter, one of which is chipped, it is reasonable to expect that the welding time of the chipped joint will be the greater. Assuming an average welding cost of $0.90 a joint and a slotting cost of $10 a mile, or $0.037 a joint, there need be a reduction of only 4.1 per cent in the welding cost to pay for the beveling at each joint. It is my observation that this saving is fully realized, over and above any saving in emergency spot welding.

Chamfering should be done when the rail is laid, by a unit that is integral with the rail gang. This will insure elimination of chipping as a result of burrs on the rail ends. This point is emphasized in the chart previously referred to, which indicates that three months after the test rails were laid, 80 per cent of the rails that were heat treated but not slotted and almost 100 per cent of those that were neither heat treated nor slotted showed evidence of chipping. At the end of the same period there was practically no chipping of the chamfered rails to be found.

Water Service Traveling Kits

What tools should be included in the traveling kit of a water service repairman?

Does Many Jobs

By J. B. Wesley
Engineer Water Service, Missouri Pacific, St. Louis, Mo.

Probably no railway employee does a wider variety of work than a water service repairman. He must be a plumber, a pipe fitter, a well worker, a ditch digger, a concrete mixer, a mechanic skilled in repairing pumps, steam engines, internal-combustion engines and minor electrical equipment.

Since his work is on the line, away from his headquarters, it becomes necessary for him to have a traveling kit containing tools that will best enable him to care for his various jobs. In setting up a standard for this equipment, due regard must be given to the type of work most generally required on his particular territory, for which reason the standard kit for one district may not be suitable for another. To some extent also he must depend on the tools supplied to the water stations. As a basis for a standard kit, the following tools should be included: Stillson wrenches, one 24 in. and one 18 in.; one 12-in. and one 8-in. S-type wrenches, with adjustable jaws; one 1½-lb. machinist hammer; one pair of 10-in. cutting pliers; one punch with long taper, ½ in. to ¼ in.; one screw driver; and one hacksaw with extra blades. In addition, the repairman should carry such miscellaneous fittings as unions, ties, ells, nipples and plugs, as his knowledge of his territory indicates is necessary.

Includes Long List

By R. N. Foster
Water Engineer, Wabash, Decatur, Ill.

I suggest the following tools for inclusion in a traveling kit for a water service repairman. Stillson wrenches, one each 8, 10, 14 and 18 in.; Crescent wrenches, one each 6, 10 and 12 in.; end wrenches, one each ⅜, ½, ⅝ and ¾ in.; one pair of 7-in., slip-joint, combination pliers; screw drivers, one each, 8 and 12 in.; cold chisels, one each, ⅜, ½ and ⅝ in.; D-point chisels, one each, ⅜, ½ and ⅝ in.; diamond chisels, one each, ⅜, ½ and ⅝ in.; caulking tools, one each, 1 in. by ¼ in., 1 in. by ⅜ in. and 1 in. by ½ in.; one yarning chisel, ⅝ in. by 10 in.; machinists hand punches, one each, ¼ in. by 5 in., 5/16 in. by 5 in. and ½ in. by 6 in.; one machinists center punch; one ball and peen hammer; pipe taps, one each, ¼, ⅜, ½, ¾ and 1 in.; one 6-ft. rule; one 12-in. hacksaw; files, one each, 10-in. flat, 10-in. half around and 10-in. three cornered; one pair of hip boots; and 30 ft. of ¼-in. rope. These tools should make it possible for a repairman to handle any ordinary job. Cases where special tools are needed, arise occasionally, and must be provided for specially.

Reduce to the Minimum

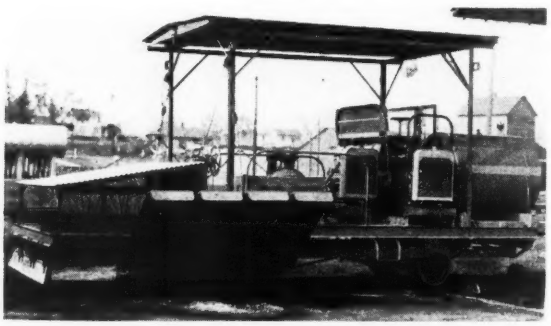
By J. P. Hanley
Water Service Inspector, Illinois Central

Equipment for a traveling kit will depend on the class of work—steam, oil-engine or electric plants, plumbing or heavy underground pipes—to be maintained. While community tools are provided by the company, it is desirable for the repairman to own a few medium heavy tools which he does not carry at all times. For this reason, he should have a secondary kit containing such tools as his experience indicates are necessary to use from time to time. This will reduce his traveling kit to the minimum, and for which I would suggest one each of the following tools: 6-in. pipe pliers; 6-in. cutting pliers; 12-in. and 18-in. pipe wrenches; machinist hammer; hacksaw; brace, with assorted drill bits; adjustable pipe die, ¼ in. to 1 in.; speed indicator; box of valve-grinding compound; gasket material; ball of candle-wick packing; and an 8-in. monkey wrench. He should also have two assorted chisels and two assorted calking tools.

New and Improved Devices

Fairmont Improves Oven-Type Weed Burner

FAIRMONT Railway Motors, Inc., Fairmont, Minn., has incorporated a number of improvements in its M27 Series F oven-type weed burner, which are designed to promote its efficiency and effectiveness. By equipping the burner with wings that extend 33½ in. farther out on each side than formerly, the width of burning has been increased from 16 ft. to 18 ft. In addition, more thorough burning over the greater width is obtained by boxing the wings at their outer ends so that the flame is turned downward instead of being allowed to curl upward. The levers that were formerly used to adjust the position of the wings have been replaced by large hand-wheels.



The New M27 Series F Oven-Type Weed Burner

A corrugated steel roof has been installed over the burner oven in order to protect the heat plates from sudden or unexpected showers. The burner operator is shielded from the oven heat by ⅜-in. Johns-Manville Transite board, which has been applied to the frame of the oven roof in front of the operator's position and also to the steel deck of the car on which the burners are mounted.

The burner is now equipped with Waukesha engines of larger capacity; a 52-hp. unit being used for propelling the car and a 38-hp. engine for operating the blower. The output of the blower has thus been increased to 3,700 cu. ft. per minute, as compared with the former maximum of 3,200 cu. ft. per minute. The blower shaft has been equipped with ball bearings at both ends and the entire blower unit has been mounted more rigidly. The performance of the blower belt drive has been improved by increasing the width of the belt to 5 in. and introducing a double-arm idler pulley.

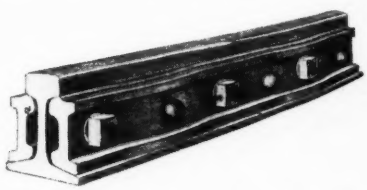
The burner car has been equipped with Davis heat-treated steel wheels, 22-in. in diameter, which have machined treads and are mounted on heat-treated axles that turn in Timken roller bearings of larger capacity than those formerly used. With the higher wheels the depth of the oven space has been increased 2 in., which is said to be of distinct advantage.

Improvements in the fuel oil system include the installation of V-belt drives on both the filler and pressure pumps, two Timken bearings in the pressure pump, and a fuel oil strainer of extra large capacity. Many pipe fittings have been eliminated through the extensive use of heavy copper tubing. The fuel valves of all six burners, together with the pressure gage, have been closely grouped on a distributing manifold, while a master valve enables the operator on the rear deck to shut off all burners at once without disturbing the individual settings. All burners can also be shut off from the pilot's seat by the driver.

By means of a worm-geared hand-wheel, sufficient pressure is said to be easily applied on the iron brake shoes to slide all four wheels in emergency. This feature also has the advantage that when once applied the brakes cannot be released until the wheel is turned backward by hand.

Controlled-Bearing Flexible Rail Joint

AFTER a number of years of satisfactory service tests of intermittent-contact, or controlled-bearing rail joint bars, brought about by the use of metal shims beneath the ends and centers of the bars, The Rail Joint Company, New York, has put on the market controlled-bearing rail joint bars, which, in themselves, produce the positive controlled bearing and other features secured earlier through the use of the shims. These bars, the purpose of which is to insure greater accuracy of fit than is possible with ordinary full-contact bars, and increased flexibility through the joint, simulating the condition obtaining throughout the unbroken portion of the rail, can be furnished in either the head-contact or headfree type, and with either four or six shoes.



Sketch of Controlled-Bearing Rail Joint, Showing Positive Center and End Bearings

The new bars are essentially the same as the standard types of bars produced by the company, except that in their final processing, they are deformed slightly, laterally to that when applied, they contact the rails, head and base, only through a limited portion through their center section and at both ends. The deformation of the bars bringing about this result consists essentially of slight outward bulges provided in them midway be-

tween their center section and each end.

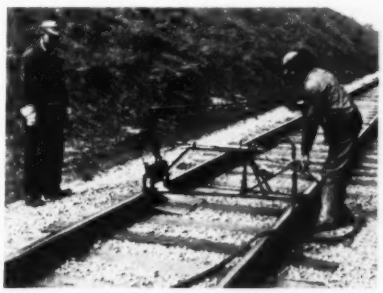
The new design of bars is said to offer a number of advantages. Because of their limited area of contact with the rails, they are said to insure a good fit, both initially and throughout the life of the joint. Whereas in the normal full-contact bars the bending and shearing stresses are concentrated largely at the center, directly beneath the ends of the rails, these stresses are distributed in the new bars throughout the non-contacting portions each side of the center where there is greater freedom to flex or bend. This, in turn, leaves the center portion of the bars free to act as a strut or support, relieved largely of bending. It is the new distribution of stresses in the bars and their increased flexibility which foster the normal wave motion of the unbroken rail through the joint.

Because of the reduced area of contact between the bars and the rail, with the resulting reduced friction set up, it is said that the new bars permit greater freedom in the joints for the equalizing of expansion and contraction, and that they, with fully tightened bolts, will not cause "frozen" joints. As a result of this feature and of the increased flexibility in the joint, it is said that the tendency of the rail ends to batter is minimized, and that joint maintenance costs are materially reduced.

Heat-Treating Rail Ends by New Process

A METHOD for the heat treatment of the running surface of rails at the joints for the purpose of effecting a marked increase in their resistance to battering has been developed by the Oxweld Railroad Service Company, Chicago. This method involves the use of a semi-automatic machine and utilizes the body of the cold rail to provide the quenching medium. Among the advantages claimed for this method as the result of its practical application on a number of railroads are accuracy and uniformity, the ease with which the process can be applied, and assurance against injury to the rail. Possibly an even more important factor in its acceptance is its low cost.

The heat-treating machine process differs considerably from the early method of single blow-pipe rail-end hardening. The new method entails the use of a sufficient number of oxy-acetylene flames so that the surface of the rail to be hardened can be brought to a high temperature before the rest of the rail has been heated materially. The balance between the heat conductivity of the rail steel and the temperature of the rail head has been definitely calculated. As a result, the simple application of a given amount of heat on this area in a definite interval of time is said to leave the rail automatically at the desired hardness without the necessity for additional quenching.



The Hardening Apparatus in Use

The Oxweld rail-end hardening apparatus is mounted in a light frame that is placed across the rails. The heating head, which is located at one end of the frame, houses several large oxy-acetylene tips that are so positioned as to apply the proper amount of heat where it is desired at the rail-ends—half of the flames play on the end of each rail at the joint. An oscillating mechanism is provided so that the operator can move the flames through a small arc across the joint. By this means, the top surface of each rail is uniformly heated to provide the proper surface hardness. The flames are so positioned that a larger number of them are located on the gage side of the rail and fewer on the outer edge, so that the wider area of hardening is applied where the greater amount of batter generally occurs.

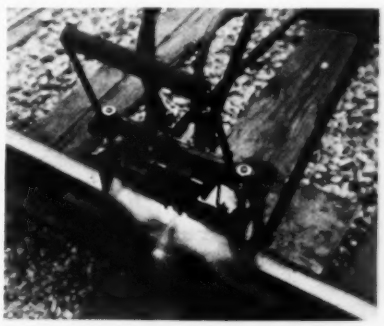
The supporting carriage of the machine is made from steel tubing with oxy-acetylene welded joints. The carriage is placed across the rails so that the heating head is directly over the joint, while the operator stands outside the opposite rail. With his left hand he controls the feed of oxygen and acetylene, and with his right hand he operates the rocker arm that oscillates the blowpipe heads back and forth across the ends of the rails so that the heat is evenly distributed over the area to be hardened.

The operator can gage the length of time that the heat has been applied by means of a timer clock and can also vary the speed and travel of the movement of the machine to suit the size and weight of the rail. Handles are provided at both ends of the machine so that it can be carried quickly to the next rail joint to be treated. The machine weighs only about 50 lb., and is readily moved from one joint to the next by two men. Vertical and horizontal adjustments are provided for spotting the heating head accurately over the rail joint so that the heat will be directed on the desired part of the rail heads.

Data compiled on a number of railroads show that the average cost of heat-treating rails by this process is less than 25 cents per joint. It takes only about 15 sec. of actual heating to bring the material to the required temperature. The method does not embody either preheating or the covering of the joint to retain the heat.

Experience has disclosed that for all practical purposes the rate of quenching and heating is independent of air temperature. In fact, sections of track have been treated with equally good results where the temperature was 20 deg. F. below or 110 deg. F. above zero. This is due to the fact that the maximum difference in temperature has relatively little influence in a heating cycle in which temperatures up to 1,500 deg. F. are being used.

The Brinell hardness of rail ends is increased about 100 points by the Oxweld process hardening, the original hardness of most rail approximating 250, while the average hardness obtained by this process is between 350 and 375. The final hardness of the rail is controllable within certain limits and the greater the surface hardness, as a rule, the shallower is the thickness of the hardened layer. It has been found advisable to hold the Brinell hardness below 400; hardening of rail above this point may result in spalling and chipping of the hardened area.



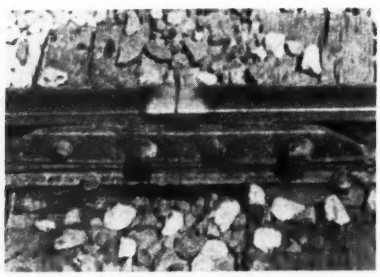
The Heating End of the Hardening Apparatus in Action

It is said that the nature of this hardening operation is such that if the operator, for any reason, varies the time or flame adjustment from the standards that have been established as best practice, the rail will not be affected adversely. The ap-

paratus and the method have been applied successfully to both head-free and standard sections of rails in weights ranging from 90 to 131 lb. per yard. The hardened area can be so controlled as to be applicable to any type of rail in use.

In addition to the machinery, the equipment required includes cylinders of oxygen and acetylene, which are carried on a pushcar, and the necessary gas lines. The crew consists of one man with the pushcar, two men to carry the equipment, the operator of the apparatus and two flagmen to protect against traffic.

The speed with which this process can be applied is a factor which makes for economy. Although as previously stated, it takes only about 15 sec. to treat each joint, additional time is consumed in moving the apparatus, in traffic interruptions and



Rail-Ends Hardened by the Process. Note that the Wider Area of Heat-Treated Metal Is On the Gage Side of the Rail

other similar delays so that the average performance is about 60 joints per hour, or about 400 joints per day.

Among the advantages claimed for the Oxweld process is the precision of the operation. The area of heat-treated portion is exactly the same on every rail of the same weight. The pattern and extent of the hardened surface on both rail ends are equal. No pyrometers are used to get these results, dependence being placed entirely on the time factor and flame adjustment. To guard against end overflow, the rail ends are cross-ground before application of the heat-treatment, and the cost of doing this is low in comparison with the effectiveness of the treatment.

The development of the Oxweld process of hardening rail ends followed as a natural sequence experience in the building-up of rail ends by the oxy-acetylene process, as it was early observed that this resulted in an almost total stoppage of end flow of the rail metal. Experiments led to the development and perfection of hand blowpipe rail-end hardening, and after investigation by the engineers of the Oxweld Railroad Service Company in conjunction with the research facilities of Union Carbide and Carbon Research Laboratories, Inc. had shown that the principle of the process was sound, a machine was developed to do the work.

Figures on the number of joints heat treated by this process to date are not available. However, the process has been applied on a number of leading railroads and several smaller lines, in all parts of the country, so that the climatic effect is definitely known. The process was first used on a short test section in December, 1932.

Solving the Problem of Weed Control

(Continued from page 397)

was used in that year, which was purchased in concentrated form and diluted with three to five parts of water, depending on the nature of the growth to be destroyed. Generally the chemical spray is used only in territory having washed gravel ballast, although it is used also in a few locations on pit run ballast where the growth of the vegetation is so dense and rapid as to make burning uneconomical.

The method of applying the chemical involves the use of a work train, consisting of a spray car at the head end, followed in the order given by two cars of solution, a car of concentrate, the engine and the caboose. Old locomotive tanks have been found more satisfactory for use in the solution train than ordinary tank cars because the domes of the tank cars are so high that the spouts of stand pipes and water tanks cannot readily be inserted in them.

The concentrate is forced into the solution cars by compressed air from the engine and is pumped from these cars onto the track by means of a rotary pump mounted beneath the spray car and driven from the axle. This arrangement, however, does not permit the transfer of chemical while the train is in operation because air cannot be taken from the engine while the train is in motion unless the engine is equipped with special piping which is quite expensive. In order to overcome this difficulty, chemical is now forced into the solution cars by air supplied by a small compressor.

This equipment generally embodies the use of 11 spray nozzles to cover an 18-ft. width of roadbed, and the rotary pump, being driven from the car axle, delivers a fixed amount of chemical per mile irrespective of the speed. A bypass and relief valve are provided, and as conditions require, the output of the spray nozzles can be varied within a reasonable range. Each nozzle is provided with an independent quick-acting valve. The quantity of solution applied per mile varies from 38 to 45 gal., for a single application, depending on the density of weed growth.

Table IV contains cost data on the use of chemicals for the years 1930 to 1933, inclusive.

The application of oil to the surface of the roadbed was made for the purpose of laying the dust, but during the recent dry years it also retarded the growth of vegetation. The Northern Pacific began oiling its roadbed in 1927. The oil tends to form a crust which retards growth; also, with each succeeding application of oil to pit-run ballast the latter becomes more sterile.

Table IV—Cost Data on Chemical Weed Destruction

Year	Miles of Track Sprayed	Chemical Used (Gals.)	Average No. Gals. per Mile	Total Cost	Av. Cost per Mile
1930	655*	50,250	77	$19,173.81	$29.27
1931	1,096†	49,209	45	17,901.94	16.33
1932	561.2	22.094	39	7,363.89	13.12
1933	1,063	43,996	41	14,875.39	14.00

*Two applications.

†Includes 212 miles of second application which required 4,851 gal.

The oiling device used consists of a flat car carrying a small frame house containing an engine and pump. Steam from the locomotive is used to operate the engine and also to atomize the oil. The oil discharge pipe from the pump is connected to a perforated pipe hung crosswise underneath the car, which is arranged to spray between the rails and to a distance of 30 in. outside the rails. An inverted gutter is hung over each rail to keep it free of oil. Two of these cars have been constructed in the company's shops.

In 1933, the track oilers were operated a total distance of 1,269 miles and applied 212,654 gals. of oil at a total cost of $5,801, or $4.57 per mile. Owing to the fact that the oilers were operated over some stretches of track more than once the cost per mile of track oiled was slightly more, or $5.36.

News of the Month . . .

R. F. C. Loans

Up to May 31 the Reconstruction Finance Corporation had authorized loans to railroads amounting to $494,134,980, of which $6,914,556 had been cancelled or withdrawn, $485,092,692 had been disbursed, and $71,654,411 had been repaid.

Employees on Railroads Show Small Increase in May

As of the middle of May the Class I railroads, excluding switching and terminal companies, had a total of 997,018 employees on their payrolls, which was an increase of 20,492 employees, or 2.10 per cent, as compared with April but a decrease of 47,090, or 4.51 per cent, as compared with May, 1934. These figures are based on preliminary reports made by the carriers to the Interstate Commerce Commission. The increase in May as compared with April of this year was accounted for largely by an increase of 10.44 per cent in the number of maintenance of way employees. Other classifications showing increases were the professional, clerical and general group (0.12 per cent) and the maintenance of equipment and stores group (0.77 per cent), while all other classifications showed decreases as compared with April.

Railroad Net Income Shows Increase in April

For April the Class I railroads of the United States had a net railway operating income of $34,625,786, which was at the annual rate of return of 2.02 per cent on their property investment, as compared with a net of $32,433,939, or 1.89 per cent, in April, 1934, according to reports compiled by the Bureau of Railway Economics of the Association of American Railroads. The net for April this year is somewhat in excess of actual earnings for the month as some railroads made credits to their operating expenses to offset accrued charges under the provisions of the railroad retirement act, which has been declared unconstitutional by the Supreme Court. Operating revenues for April amounted to $274,651,964, as compared with $265,405,934 in April, 1934, an increase of 3.5 per cent. Operating expenses in April totaled $209,327,823, compared with $200,203,270 in the same month in 1934, an increase of 4.6 per cent.

For the first four months of this year these roads had a net railway operating income of $121,282,899, or 1.81 per cent, as compared with a net of $145,130,072, or 2.15 per cent, in the corresponding period of 1934. Operating revenues for the four months totaled $1,074,709,087, as compared with $1,065,078,295 for the same period in 1934, an increase of 0.9 per cent; operating expenses of $833,802,630, compared with $793,945,653, an increase of 5 per cent.

President Asks Transport Legislation

A message recommending the passage of a program of transportation legislation was transmitted to Congress on June 7 by President Roosevelt. The President asked for passage of the bill to amend the bankruptcy statute relating to railway reorganizations, and of the bills providing for the regulation of bus, truck and waterway transportation, and extension of the emergency railroad transportation act and the office of federal co-ordinator of transportation for another year. He also reiterated his views in favor of the regulation of all forms of transportation under a single agency but added that it now seems advisable to postpone until the next session consideration of legislation for a reorganization of the Interstate Commerce Commission into a Federal Transportation Commission.

Congress has already made some progress on the bills that the President recommended for early passage. The bus and truck bill has been passed by the Senate, hearings have been held in both branches on the waterway bill, and hearings have been held before a House of Representatives committee on the reorganization bill. The resolution to extend the co-ordinator law had been passed previously by the Senate and was passed by the House on June 14.

G. M. & N. Gets Streamlined Trains

The Rebel, the first of two three-car streamlined Diesel-electric trains to be designed and built by the American Car & Foundry Co., for the Gulf, Mobile & Northern, left the Berwick, Pa., plant of the builder on June 16 on a tour of cities, prior to being placed in regular service between New Orleans, La., and Jackson, Tenn. By using U.S.S. Cor-Ten steel as the principal material of construction in these trains a substantial reduction in weight has been achieved. Each train consists of a power car with mail and baggage compartments, a buffet coach with compartments for white and colored passengers, and an observation-sleeping car. A seventh coach, without buffet facilities, is provided for use interchangeably in the two trains. Unlike most of the trains of light-weight streamlined construction which have been built during the last two years, the G.M. & N. trains are not articulated but are made up of completely separate units.

Hand-Car Race Thrills Chicago Crowds

For a brief period on June 12 six hand-cars from as many railroads, each manned by four husky trackmen, deserted their respective rights-of-way to engage in a race over street-car tracks in the "loop," or downtown, district of Chicago. This race, which was staged by the western railroads as one of the principal events in their celebration of Railroad Week, was witnessed by thousands of cheering spectators who were forced to scatter hastily on a number of occasions when cars jumped the tracks.

The race was run over a ½-mile course. Entries included hand-cars from the Chicago & North Western; the Chicago, Burlington & Quincy; the Chicago, Milwaukee, St. Paul & Pacific; the Chicago,

The Start of the First Heat in the Race

Rock Island & Pacific; the Illinois Central; and the Minneapolis, St. Paul & Sault Ste. Marie (Soo Line). With only two parallel tracks available, the race was run in three heats at one-minute intervals. The Burlington crew won the race by covering the course in 2 min. 13 sec., receiving a silver loving cup and $20.

Canadian Rail Orders

During the last month a number of additional orders for rail have been placed in Canada and in this country. The Canadian government has announced that, as a measure for the relief of unemployment, it will place orders for a total of 80,000 tons of steel rail with two companies in Canada, the rails to be delivered to the Canadian National when needed and paid for on delivery. It was said that the government will pay the carrying charges on the financing involved, pending completion of the transaction, thus obligating itself to the extent of $1,680,000. The tonnage is to be divided equally between the Dominion Steel & Coal Corporation, Sydney, N.S., and the Algoma Steel Corporation, Sault Ste. Marie, Ont. The Canadian Pacific has ordered 6,834 tons of 85-lb. rail from the Dominion Steel & Coal Company and 8,576 tons of 85-lb. rail and 12,480 tons of 100-lb. rail from the Algoma Steel Corporation.

Association News

Bridge and Building Association

Reports received by President H. I. Benjamin (S.P.) indicate that the committees are making satisfactory progress with their reports and that they will be completed well in advance of the convention, which will be held at the Hotel Stevens, Chicago, on October 15-17. Arrangements have been made whereby *Railway Engineering and Maintenance* will preprint these reports for distribution and use at the convention as was done last year.

Metropolitan Track Supervisors' Club

The annual business meeting of the club was held on the afternoon and evening of June 6, at the Hotel McAlpin, N.Y., the following officers being elected for the ensuing year: W. H. Haggerty, supervisor of track, New York, New Haven & Hartford, president; I. D. Talmadge, roadmaster, New York, Ontario & Western, first vice-president; J. R. MacAsy, supervisor, Erie, second vice-president; and G. M. Cooper, Ramapo Ajax Corporation, secretary-treasurer (re-elected). Members of the executive committee for the year are as follows: W. H. Haggerty, president-elect; E. E. Crowley, roadmaster, Delaware & Hudson, retiring president; T. E. MacMannis, supervisor, Central Railroad of New Jersey; and W. M. Ryan, supervisor, Staten Island Rapid Transit.

The Roadmasters Association

A meeting of the Executive committee was held in Chicago on June 30, with President C. W. Baldridge (A.T. & S.F.), Vice-Presidents J. J. Desmond (I.C.), and A. Chinn (Alton); Secretary T. F. Donahoe (B. & O.), Past President Elmer T. Howson *(Railway Engineering and Maintenance)*, Directors P. J. McAndrews (C. & N.W.), and L. B. LaFleur (S.P.), and Committee Chairmen E. L. Banion (A.T. & S.F.), W. Constance (C. & O.) and A. H. Peterson (C.M.St.P. & P.) in attendance. D. J. Higgins, secretary-treasurer, and Lewis Thomas, director, represented the Track Supply Association.

J. P. Corcoran (Alton) was appointed treasurer to fill the unexpired term of James Sweeney, whose death is noted on a following page.

Plans for the convention were discussed at length. President Baloridge called attention to the fact that this will be the fiftieth convention of the association and outlined plans for fitting observance of this Golden Session. He stated that the following have accepted invitations to address the convention: S. T. Bledsoe, president, A.T. & S.F. System; L. Yager, assistant chief engineer, N.P.; G. S. Fanning, chief engineer, Erie, who will speak on the Place of Transportation in Civilization and the Place of the Railways in Transportation; J. V. Neubert, chief engineer maintenance of way, New York Central System, who will discuss What the Association Has Done for the Railways and What They May Expect of It; and R. H. Ford, assistant chief engineer, C.R.I. & P., and chairman, Engineering division, A.A.R., who will speak on the Trend of Events in Engineering Problems on American Railroads. A special program with an address by a railway officer on present day maintenance problems will feature the special session of the convention on Tuesday evening.

A committee was appointed to arrange for a visit to a steel mill, following the adjournment of the convention on Thursday afternoon, to enable the members to observe the rolling of rails and the manufacture of rail joints, tie plates, bolts and spikes.

Reports of 3 of the 5 standing committees were presented in detail and discussed. Progress reports were received from the other committees indicating that all of the reports will be completed in advance of the convention. Arrangements have been made for *Railway Engineering and Maintenance* to preprint the reports of these committees in an advance convention edition for distribution and use at the meeting, as heretofore.

American Railway Engineering Association

Plans for improving the arrangements for and conduct of the convention in 1935 are under consideration by the Committee on Arrangements, which committee held a meeting with President Ford at Chicago on June 25, to discuss the suggestions which have been made with this in view.

The Board of Direction met in Detroit, Mich., on June 27, plans for a general revision of the Manual being among the chief problems under consideration. The board joined at luncheon with the Executive committee of the American Society for Testing Materials. Dr. Hermann von Schrenk, a member of the Board of Direction of the A.R.E.A., is also president of the American Society for Testing Materials and ex-officio chairman of its Executive committee. The principal object of this meeting was to lay the ground work for a closer co-operation between the two associations as a means of avoiding duplication of effort.

Four standing committees met in June. The Committee on Wooden Bridges and Trestles met in Chicago on June 20, the Committee on Ballast in the same city on June 22, and the Committee on Roadway in Detroit on June 27-28. The Track committee convened in Chicago on June 11. Incident to its study of curve elevation for high speed trains, the committee adjourned that afternoon to permit the members to ride the "400" of the North Western, the Zephyr of the Burlington and the Hiawatha of the Milwaukee to St. Paul, Minn. Completing its meeting in the latter city on June 12, the members returned to Chicago on the same trains. By this means each member attending was enabled to observe the riding conditions of two of the three roads operating these high speed streamlined trains.

Nine committees have already scheduled meetings for July and others have tentative plans for meetings during the month. Those now scheduled are, Yards and Terminals, at Toronto, Ont., on July 8; Waterproofing, at Cincinnati, Ohio, on July 8; Buildings, at Montreal, Que., on July 9; Maintenance of Way Work Equipment, at Chicago, on July 9; Iron and Steel Structures, at Cleveland, Ohio, on July 11 and 12; Economics of Railway Operation, at Erie, Pa., on July 16; Economics of Railway Labor, at Chicago, on July 16; Water Service, Fire Protection and Sanitation, at Chicago, on July 23, and Records and Accounts, at New York, on July 26.

The Track Supply Association

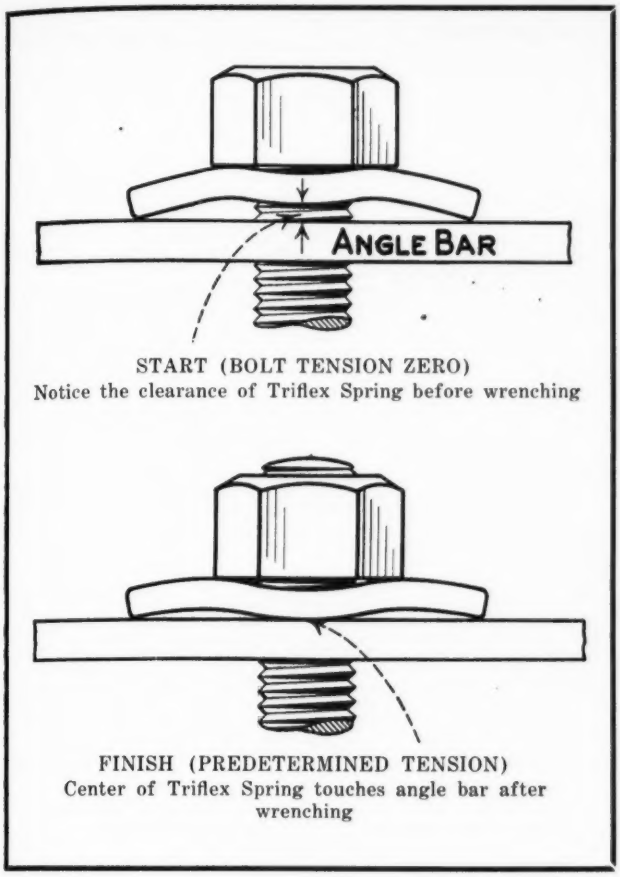
Although invitations for membership in the Track Supply Association were not sent out until June 5, President Geo. T. Willard (P. & M. Co.) and Secretary D. J. Higgins (Gardner-Denver Co.) received 23 applications prior to June 30, of which 10 were from companies who did not participate in the exhibit last year. This prompt return indicates that the exhibit this year will materially exceed that of last year in the number of companies participating.

The companies which have made reservation of exhibit space to date are as follows:

American Fork & Hoe Co.
Barco Manufacturing Co.
Buda Company
Chicago Pneumatic Tool Co.
Electric Tamper & Equipment Co.
Fairbanks Morse & Co.
Fairmont Railway Motors, Inc.
Gardner-Denver Co.
Ingersoll Rand Co.
Maintenance Equipment Co.
Nordberg Manufacturing Co.
Oxweld Railroad Service
P & M Company
Pettibone Mulliken Co.
Pocket List of Railroad Officials
Q & C Company
Rail Joint Company
Railway Engineering and Maintenance
Railway Track Work Co.
Sellers Manufacturing Co.
Templeton, Kenly & Co., Ltd.
Warren Tool Corporation
Western-Austin Company

Output of Joints and Fastenings Increases

The production of rail joints and tie plates in the United States in 1934 totaled 333,650 tons, an increase of 146,852 tons, or 79 per cent, as compared with 1933, and an increase of 190,097 tons, or 133 per cent, as compared with 1932, according to figures compiled by the American Iron & Steel Institute. The output of tie plates alone amounted to 250,447 tons, as compared with 142,414 tons in 1933, and with 109,666 tons in 1932. The production of angle splice bars was 65,714 tons in 1934 as compared with 33,307 tons in 1933; the output of fish plates was 2,298 tons as compared with 3,000 tons; and the production of other rail joints was 15,191 tons as compared with 8,077 tons.



START (BOLT TENSION ZERO)
Notice the clearance of Triflex Spring before wrenching

FINISH (PREDETERMINED TENSION)
Center of Triflex Spring touches angle bar after wrenching

IN the design of the Verona Triflex Spring provision is made for a clearance between the center of the spring and the face of the angle bar before the bolt is tightened, as shown in the upper drawing.

Approximately one complete turn of the nut brings the center of the spring in contact with the face of the angle bar, resulting in a uniform, predetermined tension.

Buy VERONA TRIFLEX SPRING Insurance

Verona Triflex Springs are calibrated to give equal and proper bolt tension permanently, thereby insuring better functioning of rail anchors and eliminating buckling and pulling apart of track when temperature changes are severe.

Verona Triflex Springs have more than double the reactive spring pressure required by the American Railway Engineering Association's specifications for spring washers. Such high reactive spring pressure insures tight joint assemblies when wear takes place in the various parts.

Verona Triflex Springs are *not* expensive.

SINCE 1873

WOODINGS–VERONA TOOL WORKS VERONA, PA.

SINCE 1873

Personal Mention

Engineering

E. M. M. Hill, engineer of construction of the Western region of the Canadian National, with headquarters at Winnipeg, Man., has been appointed also right-of-way agent.

Herman H. Pevler, supervisor of track on the Pennsylvania, with headquarters at Washington, D. C., who has been promoted to division engineer of the St. Louis division, with headquarters at Terre Haute, Ind., as noted in the June issue, was born on April 20, 1903, at Waynetown, Ind. He was educated at

Herman H. Pevler

Purdue University and entered railway service with the Pennsylvania on July 10, 1927, as an assistant on the engineering corps of the Philadelphia Terminal division. On November 1, 1927, Mr. Pevler was promoted to assistant supervisor of track, with headquarters at Camden, N. J., being transferred to Altoona, Pa., in September, 1928. On April 8, 1929, he was further advanced to supervisor of track, holding this position successively at York, Pa., Parkton, Md., Camden, N. J., Middletown, Pa., and Washington, D. C. He was located at the latter point at the time of his recent promotion to division engineer, which was effective on May 1.

Arthur Daniels, division engineer of the Twin City Terminals and Iowa & Southern Minnesota divisions of the Chicago, Milwaukee, St. Paul & Pacific, with headquarters at Minneapolis, Minn., has been appointed to the newly-created position of assistant superintendent track maintenance, with headquarters at Chicago. **D. C. Rhynsburger,** assistant engineer with headquarters at Butte, Mont., has been promoted to division engineer of the Montana division, with the same headquarters, succeeding **W. F. McDonald,** who has been transferred to the LaCrosse-River division, with headquarters at LaCrosse, Wis., where he succeeds **W. H. Vosburg. E. W. Bolmgren,** assistant engineer, with headquarters at Minneapolis, Minn., has been promoted to division engineer of the Twin City Terminals and Iowa & Southern Minnesota divisions, to succeed Mr. Daniels. **R. A. Whiteford,** assistant engineer, with headquarters at Savanna, Ill., has been promoted to division engineer of the Kansas City division, with headquarters at Ottumwa, Iowa. **E. H. Johnson,** division engineer of the Dubuque-Illinois division and the Kansas City division, with headquarters at Savanna, will retain jurisdiction over the Dubuque-Illinois division.

G. L. Staley, acting bridge engineer of the Missouri-Kansas-Texas, with headquarters at St. Louis, Mo., who has been appointed bridge engineer, was born on September 26, 1891, at Wellsville, Kan. He entered the service of the Katy on January 27, 1913, as a rodman in the engineering department, with headquarters at Waco, Tex., leaving this company in the following year to go with the Kansas City Terminal at Kansas City, Mo. During the next five years Mr. Staley served in the engineering departments of the Kansas City Southern, the Chicago, Burlington & Quincy, the Midland Valley and the Texas & Pacific, returning to the Katy on October 1, 1919, as assistant engineer at Dallas, Tex. On March 1, 1920, he was sent to St. Louis as a draftsman in the bridge department, and on October 1, 1920, he was promoted to assistant bridge engineer with the same headquarters. On July 15, 1932, Mr. Staley was appointed acting bridge engineer, holding this position until his recent appointment as bridge engineer.

Track

M. E. Morgan has been appointed roadmaster on the London division of the Canadian Pacific, with headquarters at Guelph, Ont.

F. Roy, a transitman on the Canadian National, has been appointed acting roadmaster on the Dauphin division, with headquarters at Kamsack, Sask., succeeding **J. Lagergren,** who has been granted a leave of absence.

C. F. Neu, supervisor on the Pennsylvania, with headquarters at Olean, N. Y., has been transferred to the Williamsport division, with headquarters at Lock Haven, Pa., to succeed **J. B. Jones,** who has been transferred to the Baltimore division, with headquarters at Washington, D. C. **R. W. Speidel,** assistant supervisor in the electrification forces, with headquarters at Washington, has been transferred to the maintenance of way department of the New York division, with headquarters at Jersey City, N. J.

A. W. Stone, assistant to roadmaster on the Cincinnati, New Orleans & Texas Pacific (part of the Southern), with headquarters at Somerset, Ky., has been promoted to track supervisor on the Mobile division of the Southern, with headquarters at Selma, Ala., succeeding **W. A. Long,** who has been transferred to Oxford, Ala., where he replaces **J. M. Boles,** who has been transferred to the Alabama Great Southern (also part of the Southern System), with headquarters at Tuscaloosa, Ala. Mr. Boles succeeds **W. W. Greiner,** who has been transferred. **G. A. McRoberts,** a rodman in the office of the chief engineer maintenance of way and structures at Cincinnati, Ohio, has been promoted to assistant to roadmaster at Somerset, to succeed Mr. Stone.

Bridge and Building

E. A. Kruger, general foreman in the bridge and building department of the Canadian National has been promoted to bridge and building master on the Hornepayne division, with headquarters at Hornepayne, Ont. **W. J. Coughlin,** bridge and building master, with jurisdictions over the Hornepayne and Capreol divisions, with headquarters at Capreol, Ont., will continue to have supervision over the latter division.

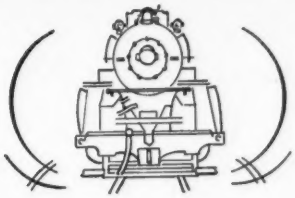
Obituary

James Sweeney, retired supervisor of track on the Chicago & Eastern Illinois, and treasurer and a past president of the Roadmasters and Maintenance of Way Association of America, died on June 18 at his home at Danville, Ill. He had been in ill health for more than a year. Mr. Sweeney retired from active service in 1933, after serving with the C. & E. I. continuously for 56 years. He was born on May 30, 1859, at Momence, Ill., and was educated at St. Viator's college,

James Sweeney

Kankakee, Ill. He entered the service of the C. & E. I. on February 26, 1877, as a trackman, serving on both section and extra gangs until July 8, 1881, when he was advanced to track foreman, with headquarters at Hillsdale, Ind., later being transferred successively to Chicago Heights, Ill., and to Kensington. On April 1, 1892, Mr. Sweeney was promoted to assistant roadmaster, with headquarters at Danville, returning to the position of track foreman at Kensington on January 1, 1893. On March 1 of the same year he was promoted to roadmaster, with headquarters at Attica, Ind., and on July 21, 1894, he was transferred

(Continued on page 422)



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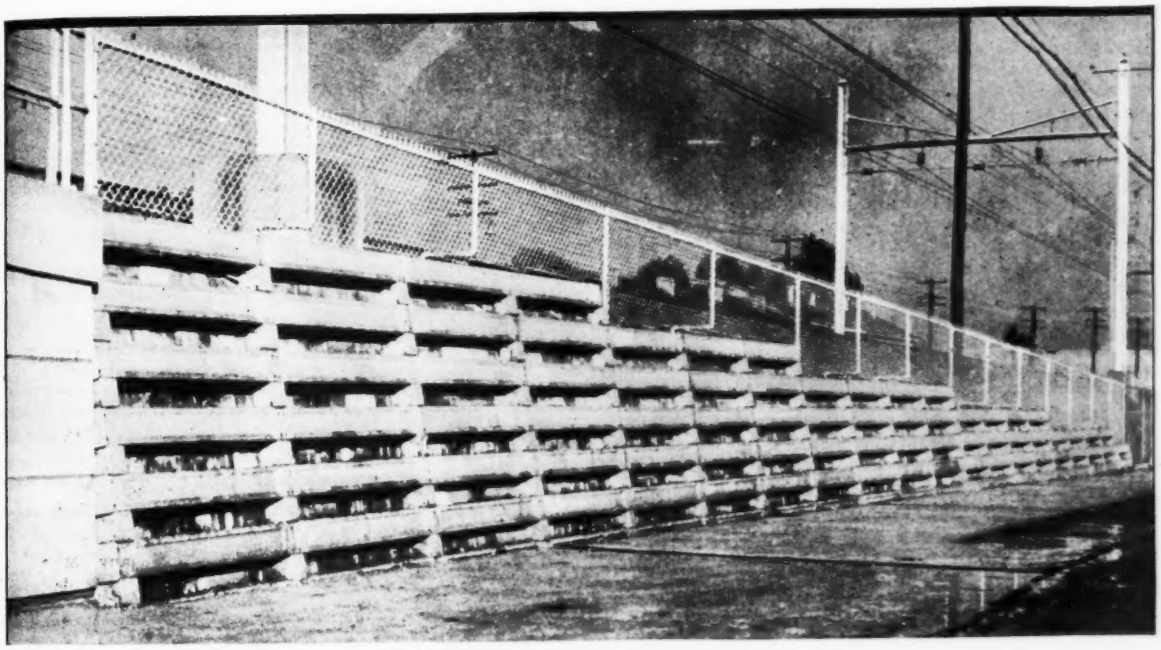
Another Prominent Railroad

erects Armco Metal Cribwall

TO PROTECT LOADING AREA



IN SELECTING a retaining wall to protect a loading area, this important railroad considered economy, durability, strength and salvageability—and found them all in Armco Metal Cribbing. The installation was made quickly and easily without special equipment.

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METAL CRIBBING

For Economy ★ ★

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to Danville as supervisor, where he remained until his retirement on May 16, 1933. Since joining the organization in 1892, Mr. Sweeney had been active in the affairs of the Roadmasters Association, serving as second vice-president in 1902, first vice-president in 1909 and president in 1910. He had served as treasurer since 1925. Mr. Sweeney was also a past president and an honorary member of the Maintenance of Way Club of Chicago.

Frank E. Millea, track supervisor on the Fitchburg division of the Boston & Maine, with headquarters at Springfield, Mass., died on June 17, following a short illness. Mr. Millea entered the service of the Boston & Maine in 1888, and until 1912, following service in the clerical department, acted as a storekeeper and a track foreman. In 1912 he was promoted to track supervisor at Springfield.

Charles A. Wilson, who was consulting engineer on the planning and construction of the Cincinnati Union Terminal, died of a heart attack on June 3, at his home at Cincinnati, Ohio. Mr. Wilson was born at Conowingo, Md., and first entered railway service in 1880, as a resident engineer on the Ohio & West Virginia (now part of the Chesapeake & Ohio), then going with the Wheeling & Lake Erie two years later as principal assistant engineer. In 1883, Mr. Wilson was appointed chief engineer of the W. & L. E., and of the Cleveland & Marietta (now part of the Pennsylvania), being transferred to the operating department of the W. & L. E. ten years later as general superintendent. From 1896 to 1904, he served as chief engineer and assistant to the president of the Cincinnati, Hamilton & Dayton (now part of the Baltimore & Ohio), and from the latter year until 1909 he served as chief engineer. For a number of years Mr. Wilson served as a special consulting engineer for the Erie and the Chesapeake & Ohio, and in 1916, he was engaged as a special consulting engineer by the B. & O., the Cleveland, Cincinnati, Chicago & St. Louis, the Pennsylvania, the Norfolk & Western, the C. & O., the Louisville & Nashville and the Southern, to make a study and prepare estimates for the necessary changes to improve the freight and passenger facilities of these railroads at Cincinnati. Mr. Wilson's studies resulted in the preparation of plans which were accepted for the construction of the Cincinnati Union Terminal and during the period of construction, which commenced in 1926, he continued to act as consulting engineer. He was a charter member of the American Railway Engineering Association.

Industrial Compressors and Vacuum Pumps—The Ingersoll-Rand Company, New York, has published a 28-page catalog, designated as catalog 7502-D, which describes and illustrates the Type 30 line of industrial compressors and vacuum pumps of this company. Tables are included which give complete information concerning each unit, and several pages are devoted to the listing of accessory compressor equipment.

Supply Trade News

General

The Edgcomb Steel Company, Philadelphia, Pa., has been appointed agent of **The Timken Steel & Tube Company,** Canton, Ohio.

The Republic Steel Corporation, Youngstown, Ohio, has moved its district sales office at Buffalo, N. Y., from 475 Abbott road to 1020 Liberty Bank building. **Thomas B. Davies** continues in charge of the office as district sales manager, assisted by his present staff.

Personal

Eugene Brandeis, formerly president of the Lundie Engineering Corporation, New York, has opened an office at 230 Park avenue, New York, to represent manufacturers of railroad supplies.

Charles R. Robinson, vice-president in charge of railroad sales of the **Inland Steel Company,** Chicago, has been elected first vice-president and general manager of sales, to succeed **Edward M. Adams,** deceased. Mr. Robinson started

Charles R. Robinson

his business career in 1890 as a salesman of tool steel for Park Brothers & Co. In 1900, he entered business for himself, handling various steel products on a brokerage basis. In 1904, he entered the employ of the Inland Steel Company as a salesman, becoming assistant general manager of sales in 1906. In October, 1908, he resigned from the Inland Steel Company to become district sales manager for the Lackawanna Steel Company at Chicago, being transferred to New York as general manager of sales in 1910. In the following year his headquarters were transferred to Buffalo, N. Y. He held the latter position until 1918, when he was elected vice-president in charge of sales. In January, 1922, Mr. Robinson returned to the Inland Steel Company coincident with that company's entrance into the rolling of standard section heavy T-rails, becoming vice-president in charge of railroad sales, which position he held until his recent election. He became a director of the Inland Steel Company in 1924 and president of the Inland Tar Company in 1930.

Robert C. Beggs has been appointed advertising manager of the **Toncan Culvert Manufacturers' Association,** Youngstown, Ohio, to succeed **H. N. Pickett.**

John W. Vogler & Company, 1218 Olive street, St. Louis, Mo., and **Thomas D. Crowley & Company,** 6 North Michigan avenue, Chicago, have been appointed by the **Cleveland Tractor Company,** Cleveland, Ohio, to represent the latter's railroad sales division respectively in the St. Louis and southwestern area, and in the Chicago area.

Trade Publications

Fairmont Motor Cars—Fairmont Railway Motors, Inc., Fairmont, Minn., has issued an 8-page folder which pictures and describes briefly its line of track motor cars.

Rotary Tools—The Chicago Pneumatic Tool Company, New York, has issued a 16-page catalog which lists, describes and illustrates the complete line of "Power Vane" pneumatic rotary tools manufactured by this company.

Cut Tacks and Nails—The complete line of tacks and small cut nails manufactured by the Republic Steel Corporation, Youngstown, Ohio, is described and illustrated in an attractively printed 24-page bulletin recently issued by the corporation.

Lufkin Measuring Devices—The Lufkin Rule Company, Saginaw, Mich., has published a 256-page catalog which lists and describes the complete line of tapes, rules and precision tools manufactured by this company. This publication is designated as general catalog No. 12 and is illustrated throughout.

Galvanized Sheet Metal Specifications—Suggestions for Galvanized Sheet Metal Specifications form the subject of an 8-page pamphlet issued recently by the American Rolling Mill Company, Middletown, Ohio. This publication is designated as AIA File No. 12 C3.

Planning Grade Separations—The Armco Culvert Manufacturers Association, Middletown, Ohio, has issued a 60-page folder entitled, "Planning Grade Separations for Stability and Economy" which points out various ways in which Armco products can be used advantageously in grade separation structures.

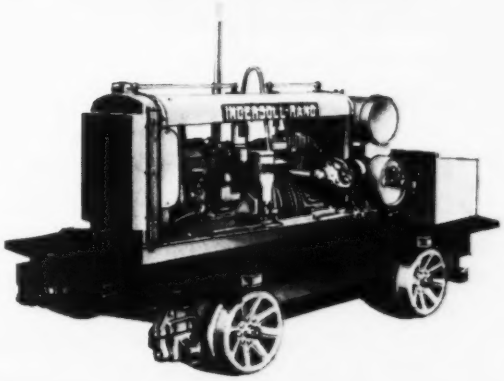
Armco Multi-Plate Pipe—The Armco Culvert Manufacturers Association, Middletown, Ohio, has issued an attractively printed 48-page brochure entitled, "Beautiful Low-Cost Bridges", which consists for the most part of a series of illustrations, including both drawings and photographs, showing the various ways in which Multi-Plate pipe has been used in the construction of attractive bridges. The booklet also contains drawings and other illustrations showing five suggested designs for the use of part-circle and full-round Multi-Plate pipe in bridge and culvert construction.

And a well tamped track is the foundation for better track . . .

High speed smooth-riding trains must have corresponding refinements in track surace and alignment.

I-R Two-Stage, Air-cooled Compressors, I-R "Crawl-Air" off track Compressors and I-R MT-3 Tie Tampers provide the quick and economical solution of these track problems. I-R Two-Stage, Air-Cooled Compressors exceed any single stage machine of equal piston displacement both in fuel economy and in the number of tie tampers or tools operated. The new MT-3 Tie Tamper has maximum power with 24 per cent less air consumption.

Whether or not high-speed track preparation is contemplated—you will find I-R Air Compressors and Tie Tampers in valuable combination for your regular track maintenance. Compressors are furnished with gasoline or oil engines—and in various capacities with different modes of transport.



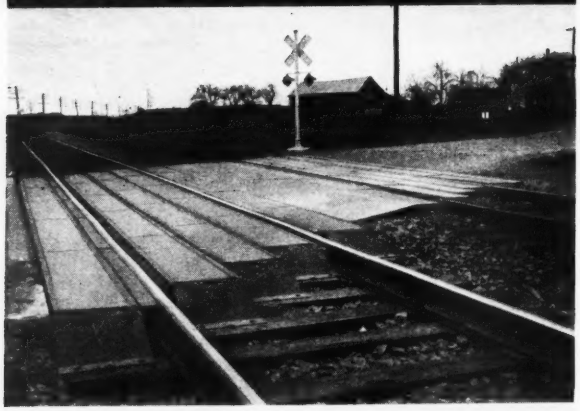
Birmingham Boston Buffalo Butte Chicago Cleveland Dallas Denver Detroit Duluth Tulsa El Paso Knoxville

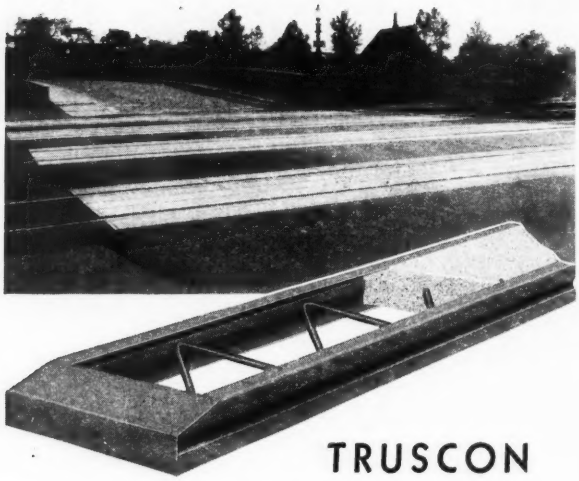
Ingersoll-Rand

11 BROADWAY, NEW YORK CITY

Los Angeles Newark New Orleans New York Philadelphia Picher Pittsburgh Salt Lake City San Francisco Scranton Seattle St. Louis Washington

END MAINTENANCE WORRIES ONCE AND FOR ALL.....





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are the answer!

Railroads using Truscon Weltrus Highway Crossings have found them to be economical, permanent, smooth, safe and silent. Designed to prevent chipping or crumbling of the concrete - even under the most severe conditions - Weltrus Crossings put an end to maintenance worries and expense. Complete information upon request. Write today for illustrated literature.

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BOOKS THAT HELP MAINTENANCE MEN

Track and Turnout Engineering

By C. M. KURTZ

Engineer, Southern Pacific Company

This new handbook for location, construction and maintenance of way engineers, transitmen and draftsmen, gives practical mathematical treatment of track layout and other problems. These are fully exemplified and worked out in detail, and illustrated with drawings of accepted designs for fixtures and track layouts. It contains original as well as a complete set of standard railway engineering handbook tables. All computing problems which may arise in track engineering are thoroughly treated.

457 pages, 116 illustrations, 33 tables, flexible binding, 5x7, $5.00

Practical Track Work

By W. F. RENCH

Formerly Supervisor, Pennsylvania Railroad

A new book giving expert information on the design, fabrication and installation of standard railroad trackwork. Thoroughly describes switch stands, switches, frogs, crossings and slip switches.

256 pages, 110 illustrations, tables, flexible binding, 5x7, $1.50

Roadway and Track

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Packed full of practical information written on a background of 25 years experience. The meat of modern maintenance practice is in this book. It is the most complete work on the subject.

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Simplified Curve and Switch Work

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This little book has practically revolutionized curve and switch calculation practice since its appearance 12 years ago. The proved accuracy of its methods has caused them to be adopted as standard practice on many roads.

Complex algebraic and geometric calculations are reduced to their simplest form and as nearly as possible to terms of simple arithmetic. Application of these calculations to the actual job is made plain by brief explanations. Drawings further clarify the subject and make the meaning of the text unmistakable. Tables of dimensions are a further help to the track foreman.

Short cut formulae are featured. String lining and tape line layouts are fully explained. While retaining practically all of the rules and principles which have been tested in previous editions, changes have been made in several detailed features to correspond to improved designs. A flexible binding makes the new edition more convenient to slip in the pocket and carry on the job.

Fourth Edition, 212 pages, 24 illustrations, 5x7, cloth, $2.00

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Name .....

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Position ..... Company ..... RE&M 7-35

FLOODS of extended proportions, which occurred in Colorado, Wyoming, Nebraska, Iowa, Missouri, Kansas, Oklahoma and Texas during the last week of May, caused untold damage over a widespread area, and culminated in a series of cloudbursts late last week that produced an unprecedented flood in the Republican river and its tributaries, and a heavy discharge from the streams flowing into the South Platte river. The result was a major catastrophe to the lines of the Chicago, Burlington & Quincy in southern Nebraska and eastern Colorado, and only slightly less damage to lines of the Chicago, Rock Island & Pacific. Interruptions to service have occurred also on the Atchison, Topeka & Santa Fe and the Union Pacific.

The first serious damage to the Burlington occurred on May 30 at Wiggins, Colo., on its Omaha-Denver line, where a flood in Bijou creek washed out a deck-plate girder bridge 363 ft. long, together with 300 to 400 ft. of approach embankments at each end, while some 3,000 ft. of track was washed out at Hillrose on the branch line from Sterling, Colo., to Brush. However, it was the extraordinary flood in the Republican river that did the greatest damage, namely, the destruction of mile after mile of track and dozens of bridges on the main line from Benkelman to Oxford, a distance of 105 miles, wiping out many of the towns, and resulting in the drowning of more than one hundred people and marooning eastbound train No. 3 at McCook. Owing to the destruction of highway bridges, it was not until June 4 that it was possible to make arrangements for the passengers of these trains to continue their journeys by means of buses or private automobiles.

Oxford Junction ... senger trains were detoured over ... liance, Sterling and Cheyenne, and over the Colorado & Southern from Cheyenne to Denver. However, wash-

No 91 *MUST* Get Through

Maintenance Mike says: "I overheard the chief tell our roadmaster the other day that there is nothing like washouts to clean out one's supply of spare materials. We are going to have to stock up pretty soon or we'll be out of luck."

In fair weather and in floods, the nation's traffic MUST be moved.

The washing out of miles of tracks —the loss of important bridges— create emergencies of the first order.

Yet they must not be permitted to interrupt the flow of foodstuffs to the cities, of raw materials to the factories.

Men by the hundreds, materials by the trainloads, must be rushed to the scene—money must be spent with apparent abandon.

This is the task confronting maintenance forces—"for No. 91 MUST get through."

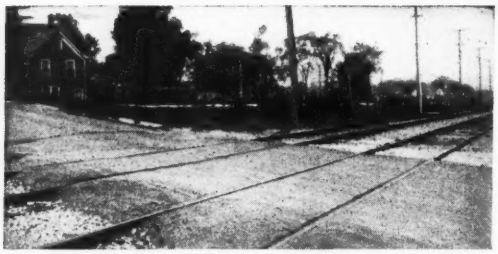
Disasters such as these, destructive though they are, enlarge the markets for those materials that enter into railway tracks and structures.

These are the markets that are reached by Railway Engineering and Maintenance.

Its readers include those officers who meet emergencies and routine demands of maintenance alike, who select and specify the materials and equipment required therefor.

RAILWAY ENGINEERING AND MAINTENANCE IS READ BY MAINTENANCE OFFICERS OF ALL RANKS

QUICK–ECONOMICAL–*DURABLE*



Grade crossing and station platform laid with Headley Asphalt Emulsions in 1923.

HEADLEY EMULSIONS CUT CROSSING AND PLATFORM COSTS

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Headley Emulsions require no expert labor . . . no heating . . . . no curing. Your own section gang can lay them —faster, cheaper, smoother. And Headley Emulsions "stay put." They will not bleed or become brittle.

Let us send you a free copy of our booklet giving specifications, mixing instructions, tips on construction, quantities of materials required for various railroad uses, etc. Address inquiries to Maloney Oil & Manufacturing Co., Exclusive Railroad Representatives (East and South), 75 West St., New York, N. Y.

Asphalt in Every Form For Railroad Construction, Maintenance and Repair

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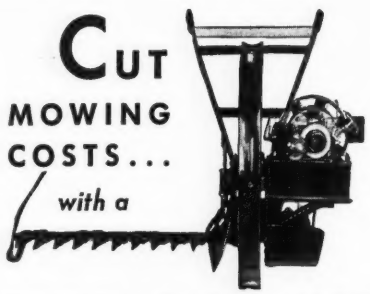
CUT MOWING COSTS... with a



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- It goes anywhere, cuts anything, and enables one man to do the work of four or more with hand scythes—eliminating costly hand mowing around fences, poles, signs, buildings, bridges, and along right-of-ways which are beyond the reach of track mowing and weeding machines.
- It has a 36-inch sickle driven by a powerful one-cylinder gasoline motor and is mounted on a free running 30-inch wheel, allowing it to be backed up, pivoted sharply, or tilted up or down slopes similar to a wheelbarrow.
- It is now produced by a recognized leader among mower manufacturers and during over four years of service, thousands of users have enthusiastically testified to its dependability.

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RAILWAY ENGINEERING AND MAINTENANCE

The list is divided into four sections:

I. Engineering and Track—5 pages
II. Bridge Engineering—2 pages
III. Building Department—10 pages
IV. Water Service—1 page

The pages are 8½ x 11 inches, mimeographed. Free on Request—Specify sections.

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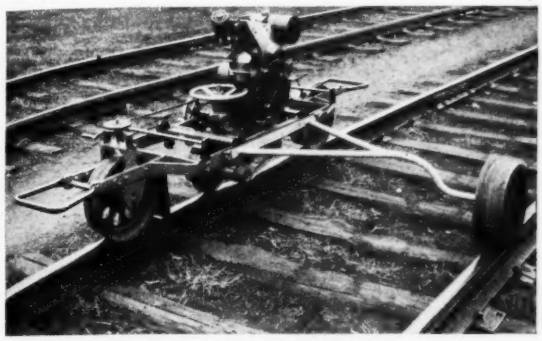
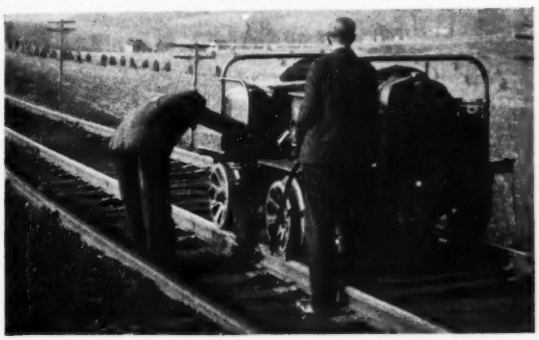
Railway Track-work Track Grinders meet every requirement encountered in the varying requirements of about 30 important roads using this equipment.



Model P-15



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Have you information on the complete line? We shall send it gladly.

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WORLD'S HEADQUARTERS FOR TRACK GRINDERS

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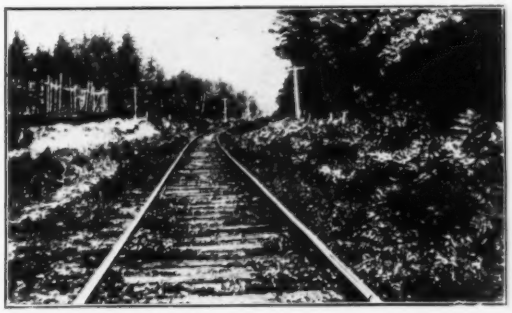

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What chemical weed killer was **used by 46 major railroads in 1934?**

What weed killer was **used by 510 Section Foremen in 1934?**

What **kills weeds for less than 10c per 100 sq. feet?**

What **kills weeds on the right of way at from** $3.00 to $5 00 per mile?

What **penetrates** weed leaves, stems, crowns and roots **and kills them completely?**

What weed killer **gives clean ballast and good drainage?**

What weed killer is **non-poisonous to livestock?**

What chemical weed killer **eliminates the fire hazard?**

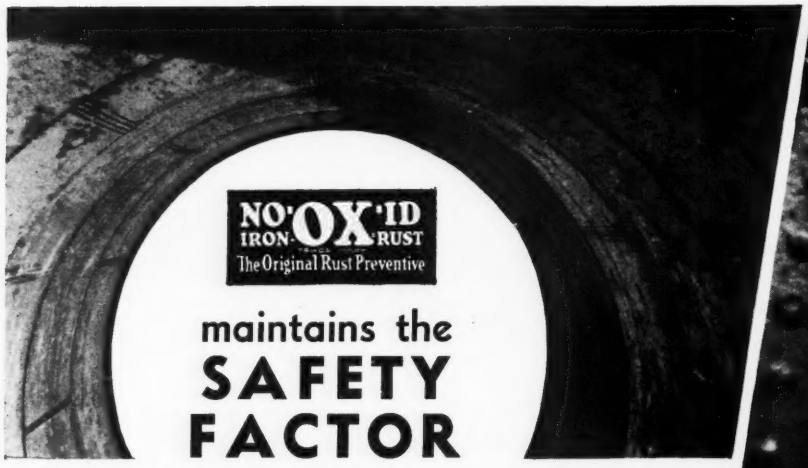
—the answer is—

ATLACIDE
TRADE MARK REG.
NON-POISONOUS WEED KILLER

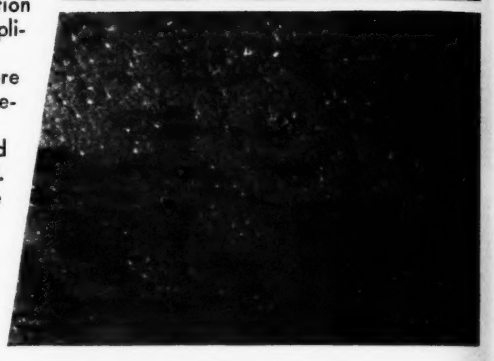
Available in 200 lb., 100 lb., and 50 lb. drums from centrally located shipping points.

CHIPMAN CHEMICAL COMPANY
INCORPORATED
BOUND BROOK, NEW JERSEY

Chicago, Ill. Houston, Texas
Palo Alto, Calif. N. Kansas City, Mo.



maintains the
SAFETY FACTOR



At the time NO-OX-ID was applied to this stand pipe a year ago, approximately 20% of the metal had been lost. The plates were shot full of pits. Corrosion had gnawed the bolt heads out of shape. Recent inspection showed no live pits, no trace of corrosion, since the NO-OX-ID application.

As long as there is an unbroken film of NO-OX-ID on the metal, there can be no more reduction of the safety factor, no need for replacement.

Maintenance engineers are able to expand programs on tank and bridge work 60% without increasing budgets, when NO-OX-ID is used. We invite your investigation of Dearborn's method of maintaining the safety factor.

DEARBORN CHEMICAL COMPANY

310 S. Michigan Ave., CHICAGO
205 East 42nd St., NEW YORK
Canadian Factory and Offices: 2454-2464 Dundas St., W., Toronto

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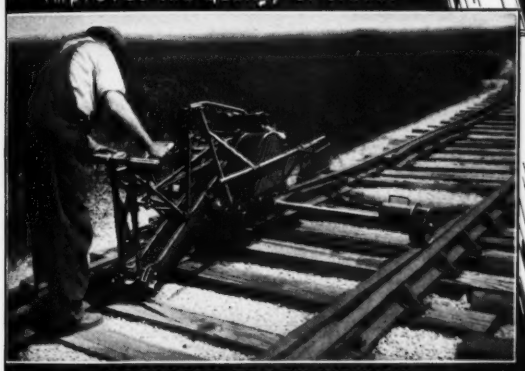
TODAY'S FASTER TRAINS DEMAND BETTER TRACK

NORDBERG ADZING MACHINE
Rail laid on machine-adzed ties improves the quality of track.



NORDBERG TRACK WRENCH
Better riding track requires that rail joints be kept uniformly tight.

NORDBERG RAIL GRINDERS
They do a smoother and faster job wherever rail grinding is done.

Now that better maintained track and roadbed are required to meet higher train speeds, it is more essential than heretofore that Nordberg maintenance equipment be used for this work. These tools were especially developed to improve the quality of track and do it with less expense. Whether for laying new rail, ballasting or rail maintenance, these tools are a part of the trend toward better track for high speed trains.

Here Are Five More Nordberg Tools!

Power Jack
Spike Puller
Utility Grinder
Rail Drill
Track Shifter

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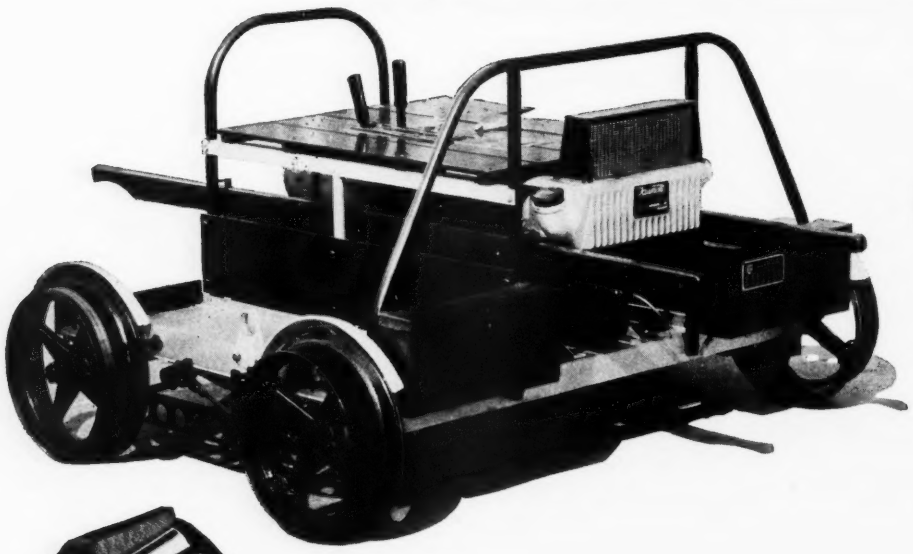
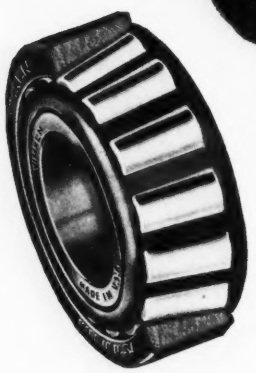
NORDBERG TRACK MACHINERY

10 TIMKEN BEARINGS

in this one man inspection car





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Maximum wheel rigidity and stability have been attained by the use of Timken Tapered Roller Bearings on both front and rear axles. At the same time, friction and axle wear have been eliminated, lubrication simplified and the wheels fully protected against radial, thrust and combined loads.

The control pulley through which power is applied to the rear axle is also mounted on Timken Bearings, assuring smooth, easy starting.

Timken Bearings are used to equally good advantage throughout the Fairmont line. Specify Timken Bearing Equipped.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN TAPERED ROLLER BEARINGS